

EPA Project No. 96-9a

1997-98 NORTHWEST PORTLAND  
AIR TOXICS MONITORING PROJECT

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March 1999

## ACKNOWLEDGMENTS

This project could not have been done without the enthusiastic assistance of many of the neighbors living in Northwest Portland. Our thanks to the Northwest District Association for its support, and to the Health and Environment Committee, especially Lisa Cohn, Robert Davies, Suzanne Orton, Amy Rosenthal, Stephanie Brooke, Jason Gass, and Jire Grimm for their interest in improving air quality. A special note of thanks to the Committee Chair, Sharon Genasci, for her tireless efforts to raise awareness of air quality issues in Northwest Portland.

Thanks also to Lisa Brenner and Tom Stibolt of Oregon Clearinghouse for Pollution Reduction (OrCPR) for their help in planning this project and to Mark Brown for his assistance in collection of samples. Our thanks to Dr. Henry Lee at EPA's Corvallis Laboratory for his help with the statistical analyses.

Neighbors who graciously allowed us to use their homes, business properties and yards to locate particulate samplers deserve special recognition. They are: Scott Lewis; Ruby and Leonard Hall; Don and Sharon Genasci; NW Awning; and Mio Sushi.

\*At the inception of this project Dr. Amundson was president of The Oregon Clearinghouse for Pollution Reduction and the primary contractor under the EPA grant. In April 1998 he left that organization but has continued to work on the project report on behalf of the NW District Association.

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## EXECUTIVE SUMMARY

### Background

For years the Oregon Department of Environmental Quality (ODEQ) has received complaints from Northwest Portland residents about odors they attribute to industrial activities in the adjacent industrial area. In November 1996, members of the Northwest District Association's Health and Environment Committee (NWDA) met with air quality staff of ODEQ to see what could be done about determining what compounds were causing nuisance odors coming from the industrial area, and in particular from a local foundry. ODEQ had received special project funding from the U.S. Environmental Protection Agency (EPA) in March 1996 to investigate concentrations of toxic air pollutants in residential areas. Since Northwest Portland was already one of several potential locations around the state being considered, the interest expressed by the neighbors was significant. In December, staff of the Oregon Clearinghouse for Pollution Reduction (OrCPR), working with the NWDA, became aware of new and inexpensive, low technology, portable air quality samplers that could be used by residents to sample for hazardous air pollutants.

The primary goal of this project, therefore, was to identify the chemicals responsible for these nuisance odors and, if possible, use this identification to determine the source(s) of the odorous material(s). We also wanted to determine if specific hazardous air pollutants are unique to these odor episodes. We planned to use available air permit and emissions information, a coordinated odor survey, and ambient monitoring as our investigative tools. A secondary objective of our study was to begin gathering data that could be used in the process of determining the Portland area's attainment status with respect to the new fine particulate ( $PM_{2.5}$ ) standard.

### Study Design

Ambient air monitoring for a broad array of gaseous and particulate pollutants was originally planned by ODEQ at a single site located in an area of the neighborhood that had been the source of the most numerous complaints. However, neighborhood residents, coordinated by Dr. Amundson through an EPA-funded contract with the Department, provided an important addition to the Department's original study plan. This grant made it possible to sample in multiple locations, as well as providing the flexibility to sample during discrete odor episodes. A fixed sampling schedule at the ODEQ "benchmark site" provided a way to link these results to earlier studies. The odor episode and forecast high pollution day sampling could then provide a look at special cases for comparison.

Odor survey forms, developed by Dr. Amundson, were distributed during June to interested residents with instructions for recording odor events. These forms allowed the neighbors to record the date and time of odor impacts, and provided space for observations about weather conditions and wind. It also asked for qualitative descriptions of the odor and for any health effects experienced.

Volatile Organic Compounds (VOC) were sampled during odor episodes by the neighborhood volunteers using Bucket samplers built by Dr. Amundson. At the ODEQ benchmark site

stainless steel (SUMMA) canister samples were used to collect 24 hour VOC samples on a regular six day schedule, for analyses by the ODEQ laboratory. Samples for Aldehyde and Ketone analysis were collected on the same schedule as the SUMMA canister samples, while Semi-Volatile Organic samples were collected on a more limited 12th day fixed schedule

Sampling equipment for particulate consisted of several devices including survey samplers and ODEQ Medium Volume samplers (MV) fitted for both PM<sub>2.5</sub> and PM<sub>10</sub>. All MV PM<sub>10</sub> and PM<sub>2.5</sub> samples were analyzed for mass concentration; a few selected samples were analyzed for metals content.

## **Results**

A major goal of this project was to test the effectiveness of citizen-run Bucket samplers for collecting air samples to measure ambient concentrations of volatile organic compounds. Results from the first phase of sampling raised several questions about the utility of the Bucket sampler, or quality control at one or both laboratories. We determined that the ODEQ laboratory had a higher minimum detection limit than the California Lab, which partially explained the disparities. Some of the other differences were found to result from equipment contamination, while some differences are not explainable at this time.

All in all the Bucket samplers proved to work remarkably well for all VOC detected in ambient air. No dramatic decreases in measured concentrations in Tedlar bags compared to those in SUMMA canisters were found. Levels of contamination with compounds such as acetone, carbon disulfide, tetrachloroethylene, and toluene in Tedlar bags need further study; however, the magnitude of the apparent contamination is relatively small.

From June through August, seven neighbors filed forty-seven odor forms. People described odors as chemical, burnt coffee / toast, hot or burnt electrical, burnt rubber, unknown burnt material, metallic, ozone, car exhaust, and welding. Two specific businesses were identified by neighbors as potential sources of odors. The air emissions from one of these sources, a small electrical motor repair shop were easily observed by the neighbors, who could visually trace the heat and smoke plume emanating from roof vents. Styrene, found in samples from the associated plume, was being used and released from the shop and ODEQ technical staff worked with the owner to eliminate styrene use.

VOC measurements using SUMMA canister sampling, with analysis by EPA Method TO-14, is capable of measuring up to 63 compounds in ambient air. Seventeen of these compounds were quantified by the ODEQ laboratory at least once. Of the 14 Aldehydes or Ketones that could be detected, eight were measured; with formaldehyde, acetone and methyl ethyl ketone appearing in all 13 samples. The method used for Semi-Volatile Organic Compound analysis is capable of identifying seventy-six compounds, of which a total of nine were measured on one or more days.

Twenty VOC were detected in the Bucket samples during strong odor events. All samples associated with strong odor events were taken within three blocks of NW Vaughn Avenue. Even though neighbors living as far away as NW 20th Avenue and Irving Avenue and NW 22nd Avenue and Johnson Avenue recorded similar odors at their homes and had Bucket samplers,

they never took samples. The main reason for not sampling was the intermittent nature of the odors at those locations; whereas, odors nearer the industrial area were more persistent.

It is clear from the VOC analyses that no one organic compound found can account for the strong industrial odors associated with the foundry near NW Vaughn Avenue. None of the concentrations monitored with the Buckets appear high enough to be smelled. It is possible that the combination of many compounds is sufficient to cause the noticeable odor, but this is an untested hypothesis. A major gap in monitoring for potential odors was not analyzing the air for nitrogenous compounds, most notably, amines such as diethyl amine, dimethyl amine, and ethylamine.

Compounds associated with industrial solvents and automobile exhaust were found routinely in all samples. Fluctuating ratios of toluene to benzene indicate that these two compounds were coming from multiple sources, since one would expect a stable ratio of these two compounds if they were coming from a single source. Results of three separate cluster analyses show that VOC do vary from location to location in Northwest Portland with samples collected at Sauvie Island less contaminated by human activities. Several samples showed chemical profiles that clearly indicated the presence of unique emissions sources but for the most part the substances measured have been routinely found in Portland and other urban area studies. Significantly, mean values for formaldehyde and acetaldehyde both exceed the cancer benchmarks for these substances. These results also are very comparable to other studies done in Portland and other urban areas, and warrant concern over a continuing problem.

During the study, there were no values of either  $PM_{10}$  or  $PM_{2.5}$  which were 80% or more of the 24-hour standards. Overall, 96% of the  $PM_{2.5}$  sample values were less than half the value of the new standard of  $65 \mu\text{g}/\text{m}^3$ . Fifty-three percent of the values were less than a quarter of the standard. The highest value of  $41 \mu\text{g}/\text{m}^3$  is approximately 63% of the daily standard. The permanent Transcon site showed highest values most of the time during this study. This site is a maximum impact site for the city, however it is probably not representative of a population exposure site since it is located in the industrial area. A maximum population exposure  $PM_{2.5}$  site should be established near the Post Office located at NW 24<sup>th</sup> and Savier since the average level measured over the 3 month study period was very close to the annual average standard.

Results of the metals analyses of the particulate filters found fourteen of the twenty elements routinely measured, on one or more samples. Many of these elements, for example aluminum and iron, are common components of soil, however they appear at higher concentrations near the foundry than in other parts of the study area. Silicon, which was higher at Transcon, suggests a more traditional impact associated with traffic-generated suspended particulate. Not surprisingly manganese and nickel, which are certainly related to the foundry, can be found in higher concentrations on the particulate samples collected nearest to the foundry. Chromium and copper were only found nearby as well. Sulfur was the one element that appeared at similar concentrations throughout the study area.

## **Conclusions**

Use of the Odor Survey Forms helped neighbors distinguish between sources, since Northwest Portland residents described a number of distinct odors. Heightened awareness of the various odors resulted in better observations of their likely sources, which, in turn, has helped the Department to work with some of the sources to reduce their neighborhood impact.

Styrene, clearly found at higher concentration in three samples, collected at one site, led directly to a nearby business using this chemical; exactly the type of situation we had hoped to find. Bucket sampling during nine other odor events failed to identify any compounds that were sufficiently unique to lead to a specific source. Aside from styrene, nineteen additional chemicals were identified in these samples. Most of these chemicals are frequently identified in urban areas and could have had their origin from any number of emissions sources common in the area. A few industrial solvents, commonly used but not commonly measured in other studies, were identified in Northwest Portland but their odors were not distinctive enough to trace to a specific source.

It was stated at the outset that this study would have limited value in assessing the health impact of the ambient concentrations of HAP, or other organics, measured in the neighborhood. The short-term episode samples did not demonstrate any danger of acute exposures for the public and they cannot be used to estimate the health effects of any longer term exposures. Still, the study again demonstrated that hazardous air pollutants can be readily measured in our largest urban area and that residents are routinely exposed to them.

In view of the upcoming implementation of the new  $PM_{2.5}$  standard, the information from this study is helpful in determining relative concentrations of  $PM_{2.5}$  in Northwest Portland. This information will be useful for future siting determinations. The permanent Transcon site showed highest  $PM_{10}$  values most of the time during this study and was often the highest  $PM_{2.5}$  site as well. This is a maximum impact site for the city, however it is probably not representative of a population exposure since it is located in the industrial area.

## **Next Steps**

We recommend that residents of Northwest Portland continue to fill out odor forms so they can provide the Department with evidence of whether odor problems are being resolved. It is clear that considerably more work will be needed to reduce the odor nuisances in this particular neighborhood

Despite our inability to identify specific odor causing chemicals this study demonstrated that Bucket sampling, with the help of neighborhood volunteers, is a valuable way to gather air quality information. The VOC analysis of these samples resulted in very credible ambient air data and indicates that interested citizens can greatly enhance the Department's ability to measure HAP throughout the state. Citizens were able to learn first-hand what was in the air they breathe. We think that ultimately this way of involving neighbors can also be a valuable tool in helping local people gain a better understanding of the sources of air pollution in their communities.

It is also recommended that one of the  $PM_{2.5}$  sites for Portland be located in the Northwest

Portland area. Elemental speciation of the particulate collected there should be seriously considered given the presence of metals emissions in the vicinity.

ODEQ has received a grant from EPA and begun working on an adequate hazardous air pollutant emissions inventory. A companion grant to establish a permanent monitoring site for these chemicals in the Portland airshed is forthcoming. Accomplishing these two tasks will go a long way toward providing the public with the information they need to understand the problems associated with hazardous air pollution, and for ODEQ to address the important sources of these emissions. However, funding must be found to maintain the inventory, to continue to operate the monitoring site, and to provide this information to the public.

## BACKGROUND

For years the Oregon Department of Environmental Quality (ODEQ) has received complaints from Northwest Portland residents about odors they attribute to industrial activities in the adjacent industrial area. Like other air regulatory agencies across the country, ODEQ regularly receives complaints about odors emanating from a variety of businesses, manufacturing industries, and agricultural operations. The Department's response can be seen in many of the current air pollution regulations, both general and specific, and in staff time devoted to complaint handling throughout the state. In some cases these odor problems have been abated through better air pollution controls, through process or product changes, or through businesses leaving an area.

In November 1996, members of the Northwest District Association's Health and Environment Committee (NWDA) met with air quality staff of ODEQ to see what could be done about determining what compounds were causing nuisance odors coming from the industrial area, and in particular from a local foundry. ODEQ had received special project funding from the U.S. Environmental Protection Agency (EPA) in March 1996 to investigate concentrations of toxic air pollutants in residential areas. Since Northwest Portland was already one of several potential locations around the state being considered, the interest expressed by the neighbors was significant. At the November meeting, however, the ODEQ Air Quality Division Administrator cautioned that funds were limited and that it was unclear the extent of monitoring that could be done in Northwest Portland.

In December, staff of the Oregon Clearinghouse for Pollution Reduction (OrCPR), working with the NWDA, became aware of new and inexpensive, low technology, portable air quality samplers that could be used by residents to sample for hazardous air pollutants. The new air sampler (described below) was developed in the San Francisco area so that citizens could take air samples when they were exposed to unknown air pollutants. Dr. Amundson called the regional EPA office in Seattle to see if funding was available to build these samplers and to pay for air sample analyses. The EPA indicated an interest in funding such a study and strongly urged the neighbors to work with staff of ODEQ to verify the efficacy of these samplers.

In February 1997, staff of OrCPR, ODEQ, and the NWDA started meeting to formulate a sampling scheme to investigate the odors in Northwest Portland. While ODEQ staff recognized there was an odor problem, they pointed out that there were many potential sources of nuisance odors and other air pollutants in the area. Attempts to track down the source of odors in Northwest Portland have been unsuccessful since the occurrence is often of short duration. They also pointed out that from a regulatory perspective it can be hard to eliminate the source of an odor without specific chemical and process knowledge.

Also in early 1997, the NWDA Health and Environment Committee staffed tables at two grocery outlets to put out information on air quality issues and to ask residents about their perception of air quality in Northwest Portland. These two weekend efforts resulted in about 450 postcards being signed by customers asking the EPA administrator, Carol Browner, to seek stricter air

quality standards for ozone and particulates. During these information efforts, residents identified the local foundry as the primary source of odors in the neighborhood.

The primary goal of this project, therefore, was to identify the chemicals responsible for these nuisance odors and, if possible, use this identification to determine the source(s) of the odorous material(s). We also wanted to determine if specific hazardous air pollutants are unique to these odor episodes. We planned to use available air permit and emissions information, a coordinated odor survey, and ambient monitoring as our investigative tools.

A secondary objective of our study was to begin gathering data that could be used in the process of determining the Portland area's attainment status with respect to the new fine particulate ( $PM_{2.5}$ ) standard.

ODEQ conducts regular particulate ( $PM_{10}$ ) sampling at NW 26th Avenue and Yeon Avenue (Transcon), and although the Transcon site shows some of the city's highest  $PM_{10}$  levels, the last time the ambient particulate standard at the site was exceeded was in 1991. That year one sample day exceeded the standard. In the winter of 1995-96 a particulate survey was conducted on the west side of Portland that included several sites in the Northwest neighborhood. The purpose of that survey was to determine if Transcon still reflected the highest particulate concentrations in the area despite changes in particulate source contributions and land use. Although the measured levels of  $PM_{10}$  on Portland's west side were all well below the standard, it should be noted that during that study, winter weather was consistently windy and rainy; conditions not conducive to high pollutant concentrations. Still, the results at that time showed that Transcon remained the highest site compared to others in Portland. This study was designed to repeat that verification process for the smaller  $PM_{2.5}$  particulate.

In an effort to comprehensively respond to Northwest Portland residents' concerns, ODEQ joined with the neighbors to carry out this study. Citizen volunteers were actively involved in gathering air pollution data related to Odors, Volatile Organic Compounds (VOC), and Particulate Matter. Since the public associates odors with potential health effects, this collaborative study offered the Department a valuable opportunity to discuss with concerned citizens their perceptions of air pollution in their neighborhood. Therefore, our final objective was to work with local residents to get a better understanding of many of the pollutants actually present in the air they breathe.

## STUDY DESIGN

Ambient air monitoring for a broad array of gaseous and particulate pollutants was originally planned by ODEQ at a single site located in an area of the neighborhood that had been the source of the most numerous complaints. However, neighborhood residents, coordinated by Dr. Amundson through an EPA-funded contract with the Department, provided an important addition to the Department's original study plan. This contract made it possible to sample in multiple locations, as well as providing the flexibility to sample during discrete odor episodes. A fixed sampling schedule at the ODEQ "benchmark site" provided a way to link these results to

earlier studies. The odor episode and forecast high pollution day sampling could then provide a look at special cases for comparison.

## **Monitoring Methodology**

### **1. Odor Survey**

Odor survey forms, developed by Dr. Amundson, were distributed during June to interested residents with instructions for recording odor events. These forms allowed the neighbors to record the date and time of odor impacts, and provided space for observations about weather conditions and wind. It also asked for qualitative descriptions of the odor and for any health effects experienced.

### **2. Meteorology**

Although meteorological equipment was set up to observe local conditions for the odor observations, the siting was established for micro-scale conditions only - in other words, this information reflected only wind speed and direction at the Post Office site. This simple meteorological set-up did not meet standard siting criteria and therefore was only intended to be used as indicator. Meteorological data from the ODEQ SE Lafayette Avenue site and the Sauvie Island site were available for general meteorological analysis and forecasting. They also provide a more accurate record of urban scale wind patterns. In general, the conditions which resulted in "forecast days" during the summer were forecast to have high temperature, a strong inversion, and low wind speeds with no predicted change in the 24-hour period. During the fall, forecast days included inversions with cool temperatures and low wind speeds.

### **3. Organics**

Volatile Organic Compounds. Odor episodes were sampled for volatile organic compounds by the neighborhood volunteers using Bucket samplers built by Dr. Amundson. This sampler, designed by Communities for a Better Environment in San Francisco, California, utilizes a small hand-held vacuum to create a negative pressure within a five gallon plastic bucket which allows for the filling of a Tedlar air sample bag. The Tedlar sample bag, surrounded by reduced air pressure from the vacuum, fills when a valve ported to ambient air is opened for two to three minutes. Tedlar bag samples were analyzed by Performance Analytical Inc., located in Canoga Park, California using modified EPA Method TO-14.

At the ODEQ benchmark site stainless steel (SUMMA) canister samples (L/Can) were used to collect 24 hour samples on a regular six day schedule for analyses by the ODEQ laboratory, also using modified EPA Method TO-14. Modified SUMMA canisters (E/Can), sampling concurrently with the Bucket samplers were used for comparison of the two sampling methods and for inter-laboratory comparisons described later in this report.



Aldehydes and Ketones. Cartridge samples for aldehyde and ketone analyses by EPA Method TO-11 at the ODEQ laboratory were collected on the same schedule as the SUMMA canister samples.

Semi-volatile compounds. A PolyUrethane Foam (PUF) sampler collected semi-volatile organics on a more limited 12th day fixed schedule. These samples were analyzed at the ODEQ laboratory using NPDES Method 625 and SW Method 8270B, also standard EPA protocols.

A list of compounds detected by these analytical methods is provided in Appendix A.

#### **4. Particulate**

Sampling equipment consisted of several devices, including: ODEQ survey samplers; ODEQ Medium Volume samplers (MV) fitted for both  $PM_{2.5}$  and  $PM_{10}$ ; and High Volume  $PM_{10}$  samplers. Although EPA has just promulgated a new  $PM_{2.5}$  standard, and with it a Federal Reference Method sampler, this sampler was not available during the study period. Consequently, some changes occurred in sampler design over the course of the project. The  $PM_{10}$  samplers used by ODEQ are Federal Reference Method samplers which use quartz filters. Particulate concentrations measured by this method are compared to the National Ambient Air Quality Standard.

The survey samplers were constructed at ODEQ laboratory and consisted of a small pump, a 7-day clock, a time totalizer, size-separating inlet, and filter holder. The equipment operated similarly to other particulate samplers where air is drawn through the size-separating inlet, across a filter, at a specific rate, for a specified time period. All survey samples and MV  $PM_{10}$  and  $PM_{2.5}$  samples were analyzed for mass concentration; a few selected samples were analyzed for metals content.

#### **Sampling Network**

The sampling locations, collection methodologies, and schedule used in this project are presented in Table 1.

The ODEQ Transcon site has been a long-term state particulate network site since 1983 and periodic site validation testing has shown it to have the highest concentrations of particulates in Northwest Portland. It was used in this study for comparison to the historical particulate data record and for a comparison to earlier ODEQ air toxics studies. A  $PM_{2.5}$  Survey Sampler was co-located with the  $PM_{10}$  High Volume (HV) sampler at Transcon.

In addition to the Transcon site, five fixed and one "roving"  $PM_{2.5}$  survey sites were established for the study. A map, site photos, and documentation can be found in Appendix B.

**Table 1. Monitoring Network and Schedule**

Site	PM	SS – PM	BUCKET	E/CAN	L/CAN	PUF	CART
Transcon	6 day (HV)						
Post Office	Daily (MV)	6 day + forecast + QA	Episode	Episode	6 day + forecast	12 day + forecast	6 day + forecast
Aspen		6 day + forecast	Episode				
Chapman School		6 day + forecast	Episode				
Awning		6 day + forecast	Episode				
Johnson		6 day + forecast	Episode				
Rover		forecast	Episode				

Forest Park Post Office located at NW 24th Avenue and Savier Avenue was the expected maximum odor impact site based on the history of complaints received from the neighborhood. Particulate and gaseous samples collected there were the primary tool for investigating the air toxics associated with odor episodes in the neighborhood. Samples were collected on both a set schedule and in response to forecast high pollution days. This was the ODEQ "benchmark" site for comparison of results obtained at the other neighborhood sites.

Local meteorology for the study area was tracked at this site using survey-type equipment. During the second phase of the study the sampling equipment, originally located centrally in the parking lot, was moved approximately 30 meters north due to construction.

Two MV samplers, one PM<sub>2.5</sub> and one PM<sub>10</sub>, were used to collect daily particulate samples. Duplicate PM<sub>2.5</sub> survey samplers (SS-PM) operated on the regular every 6th day schedule, and on forecast high temperature stagnant days for quality assurance purposes.

With the additional funding received by OrCPR we were able to considerably enhance the spatial characteristics of this study, adding other fixed sites with Bucket samplers to collect gas samples during odor episodes. Particulate survey samplers were also located at these fixed sites.

- Aspen, was located in the hills just above and to the southwest of the industrial area, near NW Aspen Avenue and Raleigh Avenue. It provided either background or neighborhood impact concentrations depending on wind patterns.
- The Chapman School site was located at NW 27th Avenue and Quimby Avenue, well within

the neighborhood, and provided additional information on exposures to children.

- The Awning site was located near the freeway bridgehead, at NW 18th Avenue and Overton Avenue, to provide information on transportation-oriented impacts and on pollutant concentrations potentially affecting new residential development North of downtown.
- NW Johnson Avenue represents a high density residential area with significant transportation impact and reported odor impact as well. This site was originally located near the corner of NW 23<sup>rd</sup> Avenue but was relocated several houses east on NW Johnson Avenue during the second and third phases of the study.
- By outfitting a van (Rover) with a survey particulate sampler, Bucket sampler, episode canister, and cartridge sampler the neighborhood group had the ability to sample at an additional site on an ad hoc basis. Rover's location was determined by Dr. Amundson based on information received from volunteers. During the course of the study additional Bucket samples were taken at Sauvie Island, north of the study area, and at Overlook, across the river east of the study area.

### **Sampling Schedule**

The study was conducted in three phases, each approximately 30 days long. Phase I was planned for July - August 1997, Phase II would be October - November 1997, and Phase III in January - February 1998. The results and observations of the first Phase could be used to determine the sampling protocol in Phase II. Only sampling for particulate was planned for Phase III, while some follow-up quality assurance work could be done in March 1998.

#### **1. Odor**

Neighbors filled out odor forms when they smelled strong odors. Those neighbors with Buckets also took air samples for determination of VOC concentrations during strong odor episodes.

#### **2. Organics**

Twenty-four hour sampling for volatile and semi-volatile organic compounds and for aldehydes and ketones was scheduled at the Post Office site to coincide with the particulate survey sampling. On forecast days, additional gas samples were collected for only 12 hours.

#### **3. Particulate**

All PM<sub>2.5</sub> survey samplers were operated on a one in six day sampling schedule. In addition, certain days were forecast to be days of potentially elevated pollution levels based on weather conditions. Survey samplers were operated on these forecast days as well. The MV samplers at the Post Office ran daily.

Sampling actually began 9 July, regularly scheduled samples were collected every sixth day and four additional days were forecast days occurred in Phase I. Sampling in Phase II, began on 1 October and four additional sample days were forecast. Phase III included only ODEQ PM<sub>2.5</sub> and PM<sub>10</sub> sampling, beginning on 17 January. There were no forecast days during January, however one additional sample was taken.

# QUALITY ASSURANCE

## Comparison of VOC Sampling Technologies

### 1. Inter-laboratory comparison

A major goal of this project was to test the effectiveness of citizen-run Bucket samplers for collecting air samples to measure ambient concentrations of volatile organic compounds (see Appendix C for details on Bucket sampler construction). As part of the contractual agreement with EPA, Dr. Amundson and ODEQ agreed to test for comparability of ambient VOC concentrations sampled with Bucket samplers and with standard EPA SUMMA canisters by taking simultaneous air samples on six separate occasions. We agreed that SUMMA canister VOC concentrations would be analyzed at the ODEQ laboratory while Bucket sampler VOC would be analyzed by a private laboratory in California (Performance Analytical, Inc.). The Tedlar bags from the Bucket samplers were shipped via an overnight delivery service and were analyzed within 48 hours after being sampled, or were discarded.

We assumed that SUMMA canister VOC concentrations would be used as the comparison standard to confirm that the Bucket sampler did not over or under estimate ambient VOC concentrations. In particular, these comparisons were made so that concerns about loss of VOC due to sorption on the Tedlar bag in the Bucket sampler could be addressed. Wang, et. al. (1996) put three VOC (trichloroethylene, 1,2-dichloroethane and toluene) into Tedlar bags and found significant reductions in their concentrations after 12 hours; however, they used concentrations up to one thousand times higher than those expected in this study. Furthermore, they also used smaller bags and sample volumes than used in this study which increases the surface to volume ratio, thus enhancing sorption.

Evacuated SUMMA canisters were kept in the Rover with extra Bucket samplers so that the driver could take the comparison samples at any time or place in Northwest Portland. To make this comparison, an evacuated SUMMA canister was opened next to the inlet of a Bucket sampler during the two and a half to three minute sampling time needed to fill the Tedlar bag. Since the SUMMA canister fills within about 15 seconds, the two samples did not "grab" the same parcel of air. Because of these differences in filling time, a similar suite of compounds, but not necessarily with the same concentrations, was expected to be detected. Comparisons were made on 22, 24 and 30 July at the same location (NW 24th Place near Vaughn Avenue) during strong industrial odor events.

### Results and Discussion

Fifteen VOC were detected with the Bucket sampler for the 22 July comparisons while no VOC were detected with the SUMMA canister (Table 2). On 24 July, 17 compounds were detected with the Bucket sampler whereas only tetrachloroethylene was detected with the SUMMA

**Table 2. Interlab Comparison of SUMMA and Bucket Samplers**

	CAS #	SUMMA	Bucket	SUMMA	Bucket	SUMMA	Bucket	SUMMA
Bucket ID		970623	P9-1	970669	P7-2	970664	P5-3	970700
Date Sampled		22-Jul	22-Jul	24-Jul	24-Jul	30-Jul	30-Jul	2-Aug
Time of Day Sampled		11:30	11:30	10:00	10:00	9:22	9:22	24 hr
Date Analyzed			23-Jul		26-Jul		31-Jul	
Compounds								
Chloromethane	74-87-3		1		1.8		1.6	
Vinyl chloride	75-01-4							
bromomethane	74-83-9							
chloroethane	75-00-3							
acetone	67-64-1		10		32		18	
trichlorofluoromethane	75-69-4		1.6		2.6		1.9	
1,1-dichloroethene	73-35-4							
methylene chloride	75-09-2		2.4		20		11	
trichlorotrifluoroethane	76-13-1		0.82tr		.88tr		.92tr	
carbon disulfide	75-15-0		6		4.9		8.2	
trans-1,2-dichloroethene	156-60-5							
1,1-dichloroethane	75-34-3							
methyl tert-butyl ether	1634-04-4							
vinyl acetate	108-05-4							
2-butanone (Methyl Ethyl Ketone)	78-93-3		2.8		2.6		5.5	
cis-1,2-dichloroethene	156-59-2							
chloroform	67-66-3							
1,2-dichloroethane	107-06-2							
1,1,1-trichloroethane	71-55-6		1		15		14	
benzene	71-43-2		2.1		2		1.9	
carbon tetrachloride	56-23-5		.66tr		.81tr		.71tr	
1,2-dichloropropane	78-87-5							
bromodichloromethane	75-27-4							
trichloroethene	79-01-6				.73tr		.89tr	
cis-1,3-dichloropropene	10061-01-1							
4-methyl-2-pentanone								
(methyl isobutyl ketone)	108-10-1							
trans-1,3-dichloropropene	10061-02-6							
1,1,2-trichloroethane	79-00-5					45.1		
toluene	108-88-3		10		17		17	
2-hexanone	591-78-6							
dibromochloromethane	124-48-1							
1,2-dibromoethane	106-93-4							
tetrachloroethylene	127-18-4			37.2	.65tr	24	.63tr	13.2
chlorobenzene	108-90-7					60.4		
ethylbenzene	100-41-4		1.1		.81tr	44.8	2.1	
m- & p-xylene	1330-20-7		4.2		3.2	104	7.6	
bromoform	75-25-2							
styrene	100-42-5		.56tr		.75tr		1.3	
o-xylene	95-47-6		1.3		.85tr	46.7	2.2	
1,1,2,2-tetrachloroethane	79-34-5					63.7		13.7
1,3-dichlorobenzene	541-73-1					135.6		32.9
1,4-dichlorobenzene	106-46-7/95501					156.2		39.5
1,2-dichlorobenzene	95-50-1/106467					122.5		33.9
1,3,5-trimethylbenzene	108-67-8					64		14
hexaachloro-1,3-butadiene	87-68-3					196		48.4
1,2,4-trichlorobenzene	12-08-1					54.8		24.7
1,2,4-trimethylbenzene	95-63-6					54.5		

canister. Alarming, tetrachloroethylene measured 37.2 micro grams per cubic meter in the SUMMA canister sample but under 1 micro gram per cubic meter in the bucket sample. On the last comparison date, 30 July, 17 VOC again were detected with the bucket sampler while 14 VOC were detected with the SUMMA canister; however, only four compounds were found by both methods and once again concentrations in the SUMMA samples were much higher than those in the Bucket samples: m- & p-xylene, 104 vs 7.6; o-xylene, 46.7 vs 2.2; tetrachloroethylene, 24 vs 0.63; ethylbenzene, 44.8 vs 2.1 (all values micrograms per cubic meter).

These results raised several questions about the utility of the Bucket sampler, or quality control at one or both laboratories. Inspection of the data indicates that 15 of 17 compounds found with Bucket samplers were in all three samples and occurred in the same relative concentrations. Although the three comparison samples were taken on separate dates, they were taken in the presence of the same strong industrial odor at the same location. This repeatability in the suite of compounds found strengthened trust in the results from the Bucket samplers. In contrast, few compounds overlapped in the analyses of the SUMMA canisters, although concentrations were relatively high. Even though earlier studies (Wang et al. 1996) showed that VOC concentrations decline over time in Tedlar bags, none of the studies indicated total loss of any VOC. Because all of the concentrations reported by the ODEQ laboratory were relatively high, the minimum detection limits for both laboratories were compared.

Differences in minimum detection limits between laboratories partially explained the disparity in results between the samplers. The ODEQ laboratory had a higher minimum detection limit than did the California laboratory because a "cryo-focuser" had failed and had not been replaced. The California laboratory's ability to monitor all VOC to 1 micro gram per cubic meter may explain most differences in the first two comparisons. This deficiency to detect low concentrations of VOC has subsequently been remedied by the ODEQ laboratory.

A more unsettling result of the comparisons was the detection of the large suite of chlorinated benzenes on 30 July in the SUMMA canister but not in the Bucket sample collected during the same odor episode. In addition, most of these same compounds were found in a subsequent 24 hour sample taken on 2 August with another SUMMA canister. The California laboratory only analyzed for four of the ten chlorinated compounds; however, these four compounds were not detected in any of the three Bucket samples. These differences are unexplainable at this time.

## **2. Intra-laboratory comparison**

The differences in detection limits between the ODEQ and California laboratories forced this study group to develop a different comparison test. To assure that the same parcel of air was in both sample devices, a SUMMA canister was filled over a 20 minute interval to about twice ambient pressure. The pressurized canister was returned to the ODEQ laboratory where a short segment of stainless steel tubing was used to attach a Tedlar bag to the SUMMA canister so that the over pressure in the canister could fill the Tedlar bag. Theoretically, this resulted in air with the same concentration of contaminants being in both SUMMA canister and Tedlar bag.

A total of four comparisons were made: two on 4 November 1997 at the Post Office site and two on 6 March 1998 at the Transcon site. Separate sites were chosen to increase the probability of monitoring different VOC sources so that a larger array of compounds could be compared. In addition, on 4 November two laboratory blanks consisting of one purged and one non-purged Tedlar bag filled with reagent grade nitrogen were sent for analyses. These two sample blanks were tested for concentrations of compounds that might contaminate purged and non-purged Tedlar bags. All samples were blind.

## **Results and Discussion**

The reporting limit for the forty-three VOC tested by the California laboratory is 1 microgram per cubic meter; however, when detected below the reporting limit the values are still provided. In comparisons between SUMMA canisters and Bucket samplers, 17 compounds were detected. Of the 17 compounds detected, 10 compounds showed similar concentrations in SUMMA canisters and Tedlar bags (Table 3).

Four compounds analyzed consistently higher in the Tedlar bags compared to the SUMMA canister: acetone, toluene, tetrachloroethylene, and methylene chloride. The purged laboratory blank filled only with reagent grade nitrogen also contained these compounds. The high methylene chloride concentrations found in the 4 November Tedlar bags suggest laboratory contamination, which is discussed later.

Three other compounds were detected in the Tedlar bags but not in the SUMMA canisters: carbon disulfide, methyl tert-butyl ether, and styrene. Carbon disulfide was always detected in the Tedlar bags (even in the laboratory blank) but was never detected in the SUMMA canisters while the other two compounds were detected only near the minimum reporting limit of 1 microgram per cubic meter.

These comparisons showed that the Bucket samplers worked very well for detection of the 10 VOC rated similar in Table 3 and indicate that the Bucket sampler could be used to test for ambient levels of these compounds. In addition, acetone, toluene, and tetrachloroethylene may be sampled with some certainty after determining a level of bias towards higher values associated with some evident contamination of the Tedlar bags with these compounds.

Methylene chloride may even be properly measured with the Tedlar bags. The Tedlar bags used for the 4 November comparison were purged in the ODEQ laboratory along with several others used for routine monitoring. All of these purged bags tested high for methylene chloride, even the nitrogen-purged laboratory blank. On the other hand, methylene chloride concentrations in bags not purged at the laboratory all tested with low concentrations.

Finally, the last three compounds detected in these samples may also be good candidates for compounds that can be monitored with the Tedlar bags, mainly because the apparent contamination concentrations are so low. Further comparisons are needed.

### Table 3. Comparison of SUMMA and Bucket VOC

Bucket ID	CAS #	SUMMA	Bucket		SUMMA	Bucket		SUMMA	Bucket		SUMMA	Bucket		Bucket
Date Sampled		50370	PDX-11-6		50309	PDX-11-5		50368	WS-7-1		50310	PDX-3-2		Lab blank
Time of Day Sampled		4-Nov	4-Nov		4-Nov	4-Nov		6-Mar	10-Mar		6-Mar	10-Mar		4-Nov
Date Analyzed		1000	5-Nov		1045	5-Nov		915	1350		940	1335		1330
Compounds			purged			purged		11-Mar	11-Mar		11-Mar	11-Mar		5-Nov
SIMILAR														
Chloromethane	74-87-3	2.3	1.5	-0.8	2.5	1.7	-0.8	1.3	1.2	-0.1	1.3	1.3	0	0
trichlorofluoromethane	75-69-4	1.7	2.4	0.7	1.9	2.4	0.5	1.6	1.6	0	1.6	1.4	-0.2	0.61
trichlorotrifluoroethane	76-13-1	0	0.73	0.73	0.9	0.74	-0.16	0.66	0.8	0.14	0.63	0.83	0.2	0
2-butanone (MEK)	78-93-3	2.7	2.6	-0.1	2.1	2.3	0.2	1.1	2.1	1	1.8	6.1	4.3	1.1
1,1,1-trichloroethane	71-55-6	0	1.1	1.1	0.74	0.93	0.19	0	0	0	0	0.52	0.52	0
benzene	71-43-2	4.8	4.6	-0.2	4.2	4.3	0.1	3.8	3.9	0.1	2.9	3.3	0.4	0
carbon tetrachloride	56-23-5	0	0.76	0.76	0.57	0.78	0.21	0.56	0.64	0.08	0.58	0.6	0.02	0
ethylbenzene	100-41-4	2.4	2.1	-0.3	1.8	1.7	-0.1	1.2	3.2	2	1	1.7	0.7	0
m- & p-xylene	1330-20-7	8.9	7.1	-1.8	6.7	5.9	-0.8	4.2	12	7.8	3.4	5.5	2.1	0.65
o-xylene	95-47-6	3.1	2.4	-0.7	2.4	2	-0.4	1.5	3.7	2.2	1.1	1.8	0.7	0
TEDLAR HIGHER														
acetone	67-64-1	8.5	14	5.5	7.6	15	7.4	3.4	6.6	3.2	3.4	15	11.6	6.6
toluene	108-88-3	14	23	9	12	17	5	8.3	11	2.7	6.5	21	14.5	3.9
tetrachloroethene	127-18-4	5.1	8.2	3.1	6.6	10	3.4	0	1.2	1.2	0	1.3	1.3	2.8
methylene chloride*	75-09-2	2.1	55	52.9	1.2	58	56.8	0.61	0.97	0.36	0.51	6.7	6.19	32
ONLY IN TEDLAR														
carbon disulfide	75-15-0	0	2.2	2.2	0	2.8	2.8	0	2.4	2.4	0	3.2	3.2	2.2
methyl tert-butyl ether	1634-04-4	0	0	0	0	0	0	0	0	0	0	1.3	1.3	0
styrene	100-42-5	0	0.73	0.73	0	0.68	0.68	0	0.55	0.55	0	0.89	0.89	0

\*Note: high values most likely laboratory contamination



All in all, the intra-laboratory comparison proved the Bucket samplers work remarkably well for all VOC detected in ambient air. No dramatic decreases in measured concentrations in Tedlar bags compared to those in SUMMA canisters were found, in contrast to the findings of Wang, et. al., 1996. Levels of contamination with compounds such as acetone, carbon disulfide, tetrachloroethylene, and toluene in Tedlar bags need further study; however, the magnitude of the apparent contamination is relatively small.

Comparison between the purged and non-purged Tedlar bags could not be made because the non-purged bag arrived at the California lab deflated. However, subsequent information indicates that Tedlar bags should be purged to reduce concentrations of contaminants.

### **Tentatively Identified Compounds**

The California laboratory also identified other compounds that separated from the 43 VOC normally identified. The laboratory produced a list of these "tentatively identified compounds" (TIC) with each sample. Concentrations for TIC from the SUMMA and bucket sampler comparisons done on 4 November and 6 March are presented in Table 4 while the TIC associated with all other samples are presented in Appendix D.

### **Results and Discussion**

The SUMMA canisters tested with lower amounts of TIC compared to the Bucket sampler in three of the four comparisons. The presence of a "background" level of TIC contaminants in the laboratory blank, nitrogen-filled Tedlar bag, is shown in Table 4, where 13 compounds with a total concentration of over 70 micro grams per cubic meter were detected. A major contaminant of the Tedlar bag appeared to be ethanol. The November comparisons taken at the Post Office site had consistently higher total TIC than did the comparison samples taken in March at the Transcon site. The Tedlar bags used in November were purged at the ODEQ lab while the bags used in March were purged at the California lab. The Bucket samples loaded from the respective SUMMA canisters did not analyze one to one with the same compounds as those in the SUMMA canister. This illustrates a problem with using the tentatively identified compounds to identify HAP not analyzed by EPA Method TO-14, although it indicates the magnitudes of additional organic compounds present in the sample.

### **Duplicate Analyses at the California Laboratory**

The California laboratory tested for repeatability in its analyses by running duplicate analyses on six of the 30 samples. These six duplicate analyses indicated a high degree of repeatability in their analyses. The duplicate concentrations were remarkably close for the 18 standard VOC detected (Appendix E) as well as for 39 tentatively identified compounds (TIC) detected (Appendix F).

**Table 4. Tentatively Identified Compounds for SUMMA and Bucket Comparisons**

Site	Post Off.			Post Off.			Blank
Sampler Type	SUMMA	Bucket		SUMMA	Bucket		Bucket
Bucket ID	50370	PDX-11-6		50309	PDX-11-5		PDX-11-2
Date Sampled	4-Nov	4-Nov		4-Nov	4-Nov		4-Nov
Time of Day Sampled	1000			1045			1330
Date Analyzed	5-Nov	5-Nov		5-Nov	5-Nov		5-Nov
Compounds			difference			difference	
propene	4		4	4	3	1	
Chlorotrifluoroethene+SO2			0			0	6
Acetaldehyde			0			0	20
carbonyl sulfide + propane		10	-10		10	-10	
Dichlorodifluoromethane	6		6	4		4	
propane	7		7	4		4	
isobutane	9	30	-21	10	20	-10	
butane		50	-50		60	-60	
n-butane	20		20	20		20	
ethanol	20	10	10	200	30	170	10
isopentane	10		10	10		10	
isopropanol	3		3			0	
Acrylonitrile			0			0	
2-methylbutane		40	-40		40	-40	4
isopropyl alcohol			0			0	4
pentane		20	-20		20	-20	
n-pentane	6		6	6		6	
2-Methylpentane	4	20	-16	4	20	-16	
3-Methylpentane			0	2		2	
isohexane			0			0	
n-hexane			0		4	-4	
Methylcyclopentane	3	5	-2	3	5	-2	
1-butanol			0			0	
3-Methylhexane			0			0	
n-Octane	3		3	2		2	
C9H20 branched alkane			0			0	
C9 branched alkane		5	-5		6	-6	2
decane			0			0	0.8
C9 branched alkane		6	-6		9	-9	3
n-Decane			0			0	
Phenol (possible artifact)			0			0	
alpha-Pinene			0			0	
1-Ethyl-3-Methylbenzene			0			0	
3-ethyltoluene	4		4	3		3	
1,2,4-Trimethylbenzene	5		5	4		4	
6-Methyl-2-heptanone			0	3		3	
n-Decane			0			0	
d-limonene			0			0	
C12 Branched Alkane		7	-7		9	-9	7
Phenyl Acetate			0			0	
Nonanal			0			0	
Undecane		3	-3		3	-3	3
C12branched alkane		10	-10		10	-10	3
C13-C14 branched alkane		5	-5			0	7
dodecane		2	-2			0	2
total	104	223		279	249		71.8

**Table 4. Tentatively Identified Compounds for SUMMA and Bucket Comparisons**

Site	Transcon			Transcon		
Sampler Type	SUMMA	Bucket		SUMMA	Bucket	
Bucket ID	50310	PDX-3-2		50368	PDX-7-1	
Date Sampled	6-Mar	10-Mar		6-Mar	10-Mar	
Time of Day Sampled	940	1335		915	1350	
Date Analyzed	11-Mar	11-Mar		11-Mar	11-Mar	
Compounds			difference			difference
propene	2		2	2	2	0
Chlorotrifluoroethene+SO2			0			0
Acetaldehyde			0			0
carbonyl sulfide + propane			0			0
Dichlorodifluoromethane	2		2	2	3	-1
propane	4	4	0	5	4	1
isobutane	2	7	-5	2	2	0
butane			0			0
n-butane	5	5	0	6	6	0
ethanol	1	20	-19	1	20	-19
isopentane	3	20	-17	4	4	0
isopropanol		4	-4		3	-3
Acrylonitrile		10	-10			0
2-methylbutane			0			0
isopropyl alcohol			0			0
pentane			0			0
n-pentane	2	6	-4	3	3	0
2-Methylpentane		2	-2		2	-2
3-Methylpentane	1		1	1		1
isohexane	1		1	2		2
n-hexane			0			0
Methylcyclopentane	1		1	1		1
1-butanol		2	-2			0
3-Methylhexane	1		1	1		1
n-Octane		3	-3			0
C9H20 branched alkane			0		2	-2
C9 branched alkane			0			0
decane			0			0
C9 branched alkane			0			0
n-Decane		10	-10			0
Phenol (possible artifact)			0			0
alpha-Pinene	1		1	2		2
1-Ethyl-3-Methylbenzene	1		1	2		2
3-ethyltoluene			0		4	-4
1,2,4-Trimethylbenzene	2		2	2	2	0
6-Methyl-2-heptanone			0			0
n-Decane		10	-10			0
d-limonene		2	-2			0
C12 Branched Alkane			0			0
Phenyl Acetate			0	2		2
Nonanal		4	-4			0
Undecane			0			0
C12branched alkane			0			0
C13-C14 branched alkane			0			0
dodecane			0			0
total	29	109		38	57	

## STUDY RESULTS AND DISCUSSION

### Odor Survey

A long history of complaints to ODEQ from neighbors in Northwest Portland about noxious odors had preceded this study. Earlier canvassing resulted in many neighbors associating the distinctive strong odors with a local foundry. In early June 1997, the NWDA distributed odor forms (Appendix G) to about 30 neighbors. From June through August, seven neighbors filed forty-seven odor forms. People described odors as chemical, burnt coffee / toast, hot or burnt electrical, burnt rubber, unknown burnt material, metallic, ozone, car exhaust, and welding. Two specific businesses were identified by neighbors as potential sources of the odors. On fourteen forms neighbors identified the local foundry as the odor source, while on three forms an electrical repair shop was identified. The dates of detection, potential sources, and odor descriptions are also presented in Appendix G.

Neighbors also ranked odor intensity on a scale from 1 (no physical symptoms) to 4 (may cause nausea or burning eyes and throat). About 55% of the odor form filers rated the odors as level 1, whereas 33% rated odors at level 2, and 10% rated odors at level 3. One individual reported that an exposure to an odor caused them to become physically ill (level 4).

### Organic Compound Measurements

While the Bucket sampling was designed to capture volatile organic compounds associated with odor events, measurement of volatile and other organic compounds by ODEQ at the Post Office site had a different purpose. These ambient air measurements, made on a fixed schedule regardless of odor impact, were intended to provide a comparison to other information on air toxics gathered previously in Portland and in other parts of the country. Generally such measurements have been made over the course of the day (i.e. 24-hour sample) so that the results may be used to represent the exposure of the general public to these compounds and thus estimate public health. The ODEQ measurements, utilizing standard methodologies, were intended to provide a link to this existing body of scientific information.

1. Aldehydes and Ketones. Analysis for aldehydes and ketones was carried out on samples collected in the Cartridge samplers at the Post Office site only, none were collected by "Rover" during odor episodes (Table 5). The three 12 hour samples were collected on forecast days during Phase I. Of the 14 compounds that could be detected with this method eight were found at measurable levels; with formaldehyde, acetone and methyl ethyl ketone appearing in all 13 samples, acetaldehyde in twelve, propanal in ten, m-tolualdehyde in six. Acrolein and hexanal appeared on single, but different, sample days at barely detectable levels.

2. Semi-volatile compounds. Semi-volatile organics were collected on ten days, half of which were forecast high pollution days. The analytical method is capable of identifying seventy-six compounds, of which a total of nine were measured on one or more days. These results are presented in Table 6. It is important to note the values obtained for Laboratory Blanks. These blanks represent simply an analysis of a "clean" foam pad that is taken through the complete sample preparation and measurement process in the laboratory; they have not been exposed to ambient air in the field. One Laboratory blank was run with each of the two groups of samples analyzed. As can be seen, these blanks contain some of the compounds also found in the air samples and the concentrations measured in the blanks varied considerably from one analysis day to the next. Phenol, pentachlorophenol, and bis(2-ethylhexyl)phthalate each are found at measurable levels once, with phenanthrene and di-n-octyl phthalate each measured several times during the study at concentrations clearly above the blank levels. The variability of the blank values makes it difficult to draw conclusions about the presence, absence or ambient concentration of the five other compounds identified.

3. Volatile compounds (SUMMA). During Phase I, three episode grab samples, four forecast samples and five regular samples were collected for VOC analysis with Canisters. One additional episode, one forecast and two regular samples were collected during Phase II. The methodology for sampling, using SUMMA canisters with analysis by EPA Method TO-14, has been found capable of measuring up to 63 compounds in ambient air. Table 7 shows the results of these analyses where 17 compounds were quantified by the ODEQ laboratory at least once. As was discussed in the earlier section on Inter-laboratory comparisons, the relatively high detection limit for VOC helps explain the low number of VOC detected.

It is notable that tetrachloroethylene is measured on all but one sample day in Phase I but does not appear in Phase II. The disappearance of this pollutant coincides with re-locating the sampling platform at the Post Office during construction. Further investigation revealed that a vent from a dry cleaning business located on NW Thurman was exhausting near the original sampling location. The appearance of hexachloro-1,3-butadiene as the sole compound measured on one day is also unusual. In Phase II the consistent appearance of methylene chloride, benzene, and toluene in samples, as well as blanks, is much different than the Phase I results.

4. Volatile Compounds (Bucket Samplers). The primary goal of this study was to identify and quantify VOC associated with strong odors in Northwest Portland. We wanted to answer the neighbors' question, "What is in our air when it smells so bad?" A secondary goal was to determine if VOC varied with odor type or location. This secondary goal was set in hopes of identifying sources of the odors so that neighbors could work to reduce their exposure to odors and any toxic compounds associated with the odors.

#### **a. What VOC are associated with strong odors in Northwest Portland?**

The study was designed for two sampling periods. In Phase I (July and August) VOC samples were taken only during strong odor events. Sampling stopped in late August so that the VOC data could be used to improve the sampling design. During July and August all Bucket samples

Table 5. Aldehydes and Ketones

COMPOUND	SAMPLE DATE	Lab Blank 9/18/97	7/15/97	7/21/97	7/24/97	7/27/97	8/2/97	8/8/97	8/11/97	8/12/97	Lab Blank 12/9/97	10/1/97	10/7/97	10/13/97	Lab Blank 12/10/97	10/19/97	10/25/97
	TIME LOCATION ANALYSIS DATE		0000-2400 Post Ofc 9/18/97	0000-2400 Post Ofc 9/18/97	0600-2000 Post Ofc 9/18/97	0000-2400 Post Ofc 9/18/97	0000-2400 Post Ofc 9/18/97	0000-2400 Post Ofc 9/18/97	0600-2000 Post Ofc 9/18/97	0745-2000 Post Ofc 9/18/97		0000-2400 Post Ofc 12/9/97	0000-2400 Post Ofc 12/9/97	0000-2400 Post Ofc 12/9/97	0000-2400 Post Ofc 12/10/97	0000-2400 Post Ofc 12/10/97	
FORMALDEHYDE		<MDL	1.09	2.43	2.31	1.67	2.26	2.03	4	3.47	<MDL	1.3	1.63	1.24	<MDL	1.57	1.59
ACETALDEHYDE		<MDL	0.91	1.67	1.74	<MDL	2.02	1.49	2.64	2.12	<MDL	1.86	1.4	<MDL	<MDL	1.55	1.68
ACROLEIN		<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.13 <sup>1</sup>
ACETONE		0.32	1.76	2.08	4.5	1.03	2.67	1.62	3.74	2.23	<MDL	1.16	0.86	0.91	<MDL	0.98	1.51
PROPANAL		<MDL	<MDL	1.39	<MDL	<MDL	1.24	1.28	1.74	1.8	<MDL	1.36	1.33	1.22	<MDL	1.08	1.22
METHYL ETHYL KETONE (MEK)		<MDL	1.65	1.52	3.67	2.06	1.89	1.63	3.74	3.42	<MDL	0.93	1.04	0.52	<MDL	1.13	0.74
m-TOLUALDEHYDE		<MDL	<MDL	<MDL	<MDL	0.94	1.17	<MDL	2.58	2.52	<MDL	1.15	1.02 <sup>1</sup>	<MDL	<MDL	<MDL	<MDL
HEXANAL		<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

all values in ug/m3

(1) &lt;MDL (less than Minimum Detection Limit) means that the substance was quantified at least once in the study but in this sample was below the quantitation limit

(2) In the first phase analysis MEK was identified as MEKCHLORONALDEHYDE because of co-elution. Second phase analysis with a new column and better separation found only MEK.

# Table 6. Semi-Volatile Organic Compounds

SAMPLE DATE	TIME	LOCATION	ANALYSIS DATE	Lab Blank	7/15/97 0000-2400 Post Ofc	7/24/97 0800-2000 Post Ofc	7/27/97 0000-2400 Post Ofc	8/11/97 0750-2000 Post Ofc	8/14/97 0800-2000 Post Ofc	Lab Blank	10/13/97 0000-2400 Post Ofc	10/15/97 0800-2000 Post Ofc	10/25/97 0000-2400 Post Ofc	10/31/97 0000-2400 Post Ofc	11/4/97 0800-2000 Post Ofc
COMPOUND															
Phenol				<MDL	<MDL	<MDL	0.034	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Diethylphthalate				0.008	0.006	0.012	<MDL	0.007	0.011	0.014	0.004	0.009	0.005	0.012	0.007
Pentachlorophenol				<MDL	0.022	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Phenanthrene				<MDL	0.027	0.028	0.030	0.058	0.054	0.009	<MDL	0.008	0.004	<MDL	<MDL
Di-n-Butylphthalate				0.028	0.042	0.039	0.021	0.031	0.029	0.043	0.008	0.021	0.006	0.018	<MDL
Butylbenzylphthalate				<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.009	0.005	<MDL	<MDL	<MDL	0.008
Bis(2-ethylhexyl)adipate				0.073	<MDL	<MDL	<MDL	<MDL	<MDL	0.014	0.011	0.012	0.005	0.012	0.009
Bis(2-ethylhexyl)phthalate				0.106	<MDL	<MDL	0.310	<MDL	<MDL	0.075	0.061	0.014	0.009	0.010	0.017
Di-n-octylphthalate				<MDL	1.870	3.960	1.080	8.120	13.300	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

all values in ug/m3

<MDL (less than Minimum Detection Limit) means that the substance was quantified at least once in the study but in this sample was below the quantitation limit





were taken within three blocks of NW Vaughn Avenue. In Phase II (October and November) VOC were sampled over a much wider area for comparison with concentrations monitored near NW Vaughn Avenue.

Historically, winds from the north/northwest predominate during July and August. This results in emissions from the industrial area being pushed into the Northwest Portland neighborhood. The wind speed and direction monitor located at the Forest Park Post Office indicated that winds in July and August of 1997 were predominantly from the NNW, as predicted.

## **Results and Discussion**

Tables 8 and 9 show the results of the Bucket sampling during Phases I and II. Twenty VOC were detected during strong odor events. All samples associated with strong odor events were taken within three blocks of NW Vaughn Avenue. Even though neighbors living as far away as NW 20th Avenue and Irving Avenue and NW 22nd Avenue and Johnson Avenue recorded similar odors at their homes and had bucket samplers, they never took samples. The main reason for neighbors not sampling farther away from NW Vaughn Avenue was the intermittent nature of the odors at those locations; whereas, odors nearer the industrial area were more persistent.

Two locations were routinely sampled to characterize odors from two readily observable local sources. NW 24th Place near Vaughn Avenue (Vau) samples were used to characterize VOC in odors from a local foundry and NW 28th Avenue between Xavier Avenue and Thurman Avenue (Ort) samples were used to characterize VOC in odors from an electrical motor shop across the street. Strong industrial odors at the Vaughn site were routinely perceived as coming from the foundry when winds from the N and NNW blew the odors across NW Vaughn Avenue. The air emissions from a small electrical motor repair shop were easily observed by the neighbors, who could visually trace the heat and smoke plume emanating from roof vents. Styrene, found in samples from the associated plume, was being used and released from the shop.

VOC samples were also taken along NW Xavier Avenue near NW 25th Avenue when odors were detected; however, the source of odors for those samples is not clear. It should be noted that several potential sources of VOC and odors are located nearby: dry cleaners, printers, a coffee roaster, repair shops, and paint and metal working shops.

It is clear from the VOC analyses that no one organic compound found can account for the strong industrial odors associated with the foundry near NW Vaughn Avenue. Ranges of odor thresholds for most of the compounds routinely detected with the Buckets, and found in samples collected by ODEQ, are presented in Table 10. None of the concentrations monitored with the Buckets appear high enough to be smelled. Even though none of the compounds detected in the Buckets reached odor threshold concentrations, it is unclear what the odor threshold would be for a combination of all of these compounds.

**Table 8. Phase I Bucket Volatile Organic Compounds**

SAMPLE DATE	7/16/97	7/21/97	7/22/97	7/22/97	7/24/97	7/28/97	7/30/97	7/30/97	7/30/97	8/6/97	8/11/97	8/19/97
TIME	10:45	7:35	11:30	13:42	10:00	10:00	9:22	13:33	14:40	15:20	14:25	
LOCATION	Vau	Dav	Vau	Vau	Vau	Vau	Vau	Dav	Ort	Vau	Ort	
ANALYSIS DATE	7/17/97	7/22/97	7/23/97	7/23/97	7/26/97	7/29/97	7/31/97	7/31/97	8/8/97	8/13/97	8/21/97	
COMPOUND												
Chloromethane	1.7	1.5	1	1.2	1.8	1.4	1.6	1.5	1.7	1.7	1.6	1.8
Acetone	19	28	10	18	32	27	18	26	37	43	48	35
Trichlorofluoromethane	1.9	1.7	1.6	1.8	2.6	2.4	1.9	2	2.1	2.2	2.1	1.8
Methylene chloride	1.4	1.7	2.4	2.6	20	15	11	15	1.6	11	8.7	3.9
Trichlorotrifluoroethane	0.64	0.59	0.82	6.1	0.88	0.9	0.92	1	0.9	0.88	0.87	0.81
Carbon disulfide	2.3	7	6	0.84	4.9	6.8	8.2	7.3	8	5.6	8.9	7.3
Methyl tert-butyl ether	0	0	0	0	0	0	0	0.81	0	0	0	0
Methyl ethyl ketone	3.4	3.1	2.8	3.5	2.6	2.9	5.5	4.1	4.9	7.8	9	8.6
Chloroform	0	0	0	0.87	0	0	0	0	0	0	0	0
1,1,1-Trichloroethane	0.94	1.1	1	14	15	15	14	27	2.7	14	9.8	3.2
Benzene	2.8	2.8	2.1	4	2	1.5	1.9	2.4	2.2	2	2.9	4.4
Carbon tetrachloride	0.73	0.76	0.66	0.69	0.81	0.78	0.71	0.75	0.71	0.85	0.78	0.65
Trichloroethene	0	0	0	0	0.73	0.79	0.89	0.75	6.1	6.2	1.6	2.1
Methyl iso-butyl ketone	0	0	0	0	0	0	0	1.1	2.2	0	0.68	1.2
Toluene	10	14	10	24	17	13	17	27	12	22	38	25
Tetrachloroethene	0	0	0	1	0.65	0	0.63	0.79	1.6	2	0.82	0.74
Ethyl Benzene	0.94	1.5	1.1	1.2	0.81	0.83	2.1	1.5	3.1	1.4	4.3	2.2
m,p - Xylene	3.4	5.6	4.2	4.7	3.2	3	7.6	5	9.6	4.8	17	6.6
Styrene	0.73	1.1	0.56	0.69	0.75	0.8	1.3	1.8	53	22	2.1	41
o - Xylene	1.1	1.9	1.3	1.4	0.85	0.9	2.2	1.6	2.4	1.7	5.1	2

all values in ug/m3

**Table 9. Phase II Bucket Volatile Organic Compounds**

AMPLE DATE	10/15/97	10/15/97	10/15/97	10/15/97	10/15/97	10/16/97	10/16/97
TIME	14:20	14:22	13:40	13:40	13:50	14:22	14:39
LOCATION	Sau	Sau	Ovl	Coh	Vau	Tm	Awn
ANALYSIS DATE	10/16/97	10/16/97 purged	10/16/97 purged	10/16/97 purged	10/16/97 purged	10/17/97 purged	10/17/97 purged
COMPOUND							
Chloromethane	1.5	1.5	1.4	1.5	1.7	1.4	1.7
Acetone	20	7.2	22	18	31	21	54
Trichlorofluoromethane	1.6	1.6	2.8	1.8	2.3	1.9	2.1
Methylene chloride	0	0	0.99	1.5	1.6	2.2	5.4
Trichlorotrifluoroethane	0.84	1	1.2	1	1.8	0.72	0.82
Carbon disulfide	5.8	1.4	1.9	1.6	4.7	1.7	1.2
Methyl tert-butyl ether	0	0	0	0	6.6	0	2.4
Methyl ethyl ketone	9	2.3	6.4	9.7	11	9.7	14
Chloroform	0	0	0	0	0	0	0.55
1,1,1-Trichloroethane	1.1	1.5	3.1	0.78	33	0.97	41
Benzene	0.77	0.92	1.7	2.7	5.4	6.7	7.1
Carbon tetrachloride	0.61	0.61	0.62	0.6	0	0.69	0.78
Trichloroethene	0	0	0.83	0.81	1.3	2.6	210
Methyl iso-butyl ketone	0	0	0	0	1.8	0.72	1.5
Toluene	4.6	4.2	7.7	13	53	22	48
Tetrachloroethene	0	0.8	0	0	3.3	1.3	2.5
Ethyl Benzene	0	0	1.2	3.3	4.6	4.8	4.9
m,p - Xylene	1.3	1.1	3.6	11	15	16	14
Styrene	0.6	0	0.51	0	1.8	0	2.1
o - Xylene	0	0	1.2	3.3	4.9	5.3	4.9

all values in ug/m3

Many of the potentially odorous compounds that may be emitted from foundries (Gschwandtner and Fairchild, 1992) were detected:

- Aromatics - benzene, ethylbenzene, toluene, and p-xylene;
- Aldehydes - acetaldehyde, formaldehyde;
- Ketones - acetone, methyl ethyl ketone;
- Esters - di-n-butyl phthalate

In addition to the standard VOC analysis, the first four odor samples collected and shipped to the California laboratory were analyzed for reduced sulfur compounds but none of the 20 compounds that can be detected with this analysis were found. Since all four of the samples were associated with the most common industrial odor in Northwest Portland it appeared that these sulfur compounds were not detectable in the odor episodes and these analyses were stopped. Furthermore, earlier studies had indicated that the Tedlar bags used in the Bucket samplers may not be an effective medium for collecting reduced sulfur compounds.

A major gap in monitoring for potential odorous compounds from the foundry was not analyzing the air for nitrogenous compounds, most notably, amines such as diethyl amine, dimethyl amine, and ethylamine.

The highest concentration for any VOC monitored with the Bucket samplers was 210 micro grams per cubic meter of trichloroethene found on 16 October near NW 18th Avenue and Overton Avenue. High levels of toluene, benzene and acetone were also found in that sample. No specific source was positively identified as contributing to these high values, although there are several businesses in the area that could be using solvents.

Compounds associated with industrial solvents and automobile exhaust were found routinely in all samples. Fluctuating ratios of toluene to benzene indicate that these two compounds were coming from multiple sources, since one would expect a stable ratio of these two compounds if they were coming from a single source.

**Table 10. Odor Thresholds for VOC Detected with Bucket Sampler**

Compounds	CAS #	Odor low ug/m <sup>3</sup>	Description of Odor	High conc. Measured ug/m <sup>3</sup>	Notes
Chloromethane	74-87-3	-	sweet	1.8	freon 11 freon 113
trichlorofluoromethane	75-69-4	28000	sweet	2.8	
trichlorotrifluoroethane	76-13-1	342000	sweet	6.1	
2-butanone (MEK)	78-93-3	738	sweet, acetone-like	11.0	from CS2 from CH4
1,1,1-trichloroethane	71-55-6	-	sweet, solventy	41.0	
benzene	71-43-2	4500	sweet, pungent	64.5	
carbon tetrachloride	56-23-5	60000	sweet, pungent	0.9	from petroleum from coke
tetrachloroethene	127-18-4	31356	chlorinated solvent	53.8	
ethylbenzene	100-41-4	8700	aromatic	4.9	
m- & p-xylene	1330-20-7	348	sweet	39.6	from petroleum from coke
o-xylene	95-47-6	348	sweet	13.3	
acetone	67-64-1	47467	minty chemical, sweet	54.0	
toluene	108-88-3	8025	rubbery, mothballs	53.0	from petroleum from coke
methylene chloride*	75-09-2	17550	floral, pungent		
carbon disulfide	75-15-0	540000	sweet	26.5	
methyl tert-butyl ether	1634-04-4	24	disagreeable, sweet	8.9	inhibited uninhibited
trichloroethene	79-01-6	-	solventy	6.6	
styrene	100-42-5	1134	solventy, rubbery	210.0	
acetaldehyde		430	solventy, rubbery	53.0	
formaldehyde		202	solventy, rubbery	2.6	
		0.2	green, sweet, fruity	4.0	
		1470	pungent, hay		

These are the range of odor thresholds reported for a given chemical (from Ruth, 1986).

Odor low is the lowest odor threshold reported.

The irritation level is that level at which the compound causes irritation to the subject.

**b. Do VOC concentrations vary with location and odor?**

In Phase II (October and November), we asked if VOC concentrations varied around the Northwest industrial area, since the 3 locations sampled in July and August covered a relatively small geographic area. Thus, samples were taken upwind (Sauvie Island) and downwind (Dover and Awning sites), on the southwest edge (Savie) and the northeast edge (Overlook), along with Transcon in the midst of the industrial area (Table 9). Sampling took place on 15 and 16 October. On these dates, winds were light and from the northwest.

The industrial solvents, benzene, toluene, xylene, acetone, methyl ethyl ketone, 1,1,1-trichloromethane, ethylbenzene, o-xylene, carbon disulfide, and methylene chloride were not detected or were found in low concentrations at Sauvie Island, upwind of the industrial area on 15 October, but were found in higher concentrations in all other samples. We assume these elevated concentrations are coming from the industrial area and from the increase in mobile sources in the city.

Chloroform, methyl tert-butyl ether, MEK, and tetrachloroethene occurred sporadically. Carbon tetrachloride appeared in almost all samples at or below 1 micrograms per cubic meter.

Three compounds, chloromethane, trichlorofluoromethane, and trichlorofluoroethane appeared consistently in all samples below 3 micrograms per cubic meter. The universal appearance and low variance in concentrations of these compounds indicate they are associated with background concentrations. These measurements of chlorofluorocarbons (freons) indicate how pervasively human activities have polluted our atmosphere.

Standard multivariate statistical analyses were used to determine if VOC compositions or concentrations varied significantly from location to location. Because of the survey nature of the study (lack of pre-design) and the relatively low number of samples taken, rigorous analyses of the data are not warranted. We used cluster analysis to determine if VOC type and quantity varied significantly from site to site. Cluster analyses are used with multi-variable data sets (in this case VOC concentrations in each sample) to "cluster" samples that overall are closest to one another. This analysis also results in indicating which samples are least like other samples.

Time was not used as a factor in this analysis. Because most samples were taken during strong odor events and the strong odors always occurred at specific locations, we used location as a group classification. Thus, the cluster analysis tests for whether VOC concentrations associated with particular odors (locations) are similar or different. Since wind speed and direction varies with time, a fixed location does not necessarily represent exposure from a specific source; therefore, these data can not be used to identify specific sources.

The data used for the cluster analyses included 25 separate samples with concentrations of 18 VOC. A total of 20 VOC were found in the 25 samples, but two compounds were eliminated from the analyses: methylene chloride and chloroform. Methylene chloride was eliminated from the analyses because of the likelihood that several high values recorded for 4 November samples resulted from laboratory contamination. Chloroform was eliminated because it occurred in only

two samples at concentrations below the reporting limit.

The SUMMA canister versus Bucket sample comparisons made on 4 November were also used in the cluster analyses. The 4 November samples were taken directly downwind of the industrial area at the Post Office site, but varied from previous samples taken near the site in that they were planned (not initiated by strong odor) and were collected over a 20 minute interval instead of the routine 2.5 to 3 minute interval. Odors were present during the 4 November collection but they were intermittent and varied among odors best described as solvent, burnt coffee, burnt toast, and burnt electrical.

## **Results and Discussion**

Results of three separate cluster analyses are presented in Table 11. These analyses show that VOC do vary from location to location in Northwest Portland. Two of the analyses used the centroid hierarchical test and one used Ward's minimum variance test. Sites not associated with strong odor events were all in Cluster 1, regardless of location. Cluster 1 had the lowest cumulative VOC concentrations, which is not unexpected given that it likely represents general urban air without a specific point source impact.

The most chemically distinctive sample was taken at the Awning site on October 16 when the odor was not particularly strong. This sample had by far the highest concentration of any VOCs sampled: 210  $\mu\text{g}/\text{m}^3$  of trichloroethene. In addition, it also contained high levels of toluene, methyl ethyl ketone, acetone, ethylbenzene and 1,1,1-trichloroethane. This sample always sorted from the other samples. It is clear that for some compounds there is not a good correlation between odor intensity and pollutant concentration, offering additional evidence that the VOCs measured routinely during the study were not contributing to the odor complaints.

Styrene proved to be an excellent marker for samples taken at the Orton site. Styrene concentrations ranged from 22 to 53  $\mu\text{g}/\text{m}^3$  in the three Orton samples; whereas, the next highest concentration of styrene monitored anywhere else was 2.1  $\mu\text{g}/\text{m}^3$  at the Awning and Dover sites. The three Orton samples clustered together.

### **c. How do these results compare to other studies in Portland and elsewhere?**

In our original workplan we intended that the 24 hour SUMMA canister sampling and analysis would provide a link between the existing body of ambient HAP data currently available (using the same sampling and analysis methods) and the Bucket sampling results we would obtain in this study. The earlier Quality Assurance section of this report discusses some of the issues surrounding the canister results which preclude this from happening. Both the identification and the concentrations of the compounds found in the canisters makes it difficult to relate these VOC results to other studies. It is our judgement that the results obtained with Bucket sampling demonstrated sufficient accuracy and precision, for most compounds found, to stand on their own. All of the Bucket sampler results can be found in Appendix D.

**Table 11. Statistical Test for Similarities in VOC Concentrations from 7 Locations**

Centroid Heirarchical Cluster Analysis				Ward's Minimum Variance Cluster Analysis			
Sites	4 Cluster		5 Cluster	4 Cluster			
	cluster #	cluster #		cluster #	cluster #		
SUMMA	1	1	1	1	1		
SUMMA	1	1	1	1	1		
Post Ofc	1	1	1	1	1		
Post Ofc	1	1	1	1	1		
Post Ofc	1	1	1	1	1		
Sauvie	1	1	1	1	1		
Sauvie	1	1	1	1	1		
Overlook	1	1	1	1	1		
Savler	1	1	1	1	1		
Dover	3	3	3	3	2		
Dover	1	1	1	1	1		
Dover	1	1	1	1	1		
Dover	1	1	1	1	1		
Dover	1	1	1	1	1		
Dover	1	1	1	1	1		
Dover	1	1	1	1	1		
Dover	1	1	1	1	1		
Dover	3	3	4	4	2		
Davies	1	1	1	1	1		
Davies	1	1	1	1	1		
Orton	2	2	2	2	3		
Orton	2	2	2	2	2		
Orton	2	2	2	2	2		
Transcom	1	1	1	1	1		
Awning	4	4	5	5	4		
cluster 5							
cluster 4	Awning	cluster 4	1 Dover	cluster 4	Awning		
cluster 3	2 Dover	cluster 3	1 Dover	cluster 3	2 Orton		
cluster 2	3 Orton	cluster 2	3 Orton	cluster 2	1 Orton, 1 Davies, 6 Dover		
cluster 1	rest	cluster 1	rest	cluster 1	rest		



That said, it is instructive to look at other studies of urban air toxics to provide a context for assessing the significance of the pollutants measured in this study. Table 12 provides a comparison of the range of short-term episode VOC values obtained from the Bucket samples with mean values measured in other Portland-area studies. Two points must be kept in mind when making these comparisons. First, a one hundred-fold difference in measured concentrations of environmental samples is not unusual. Second, this variability increases as the sample collection time decreases and becomes more affected by changes in wind direction. Considering this second point from another perspective, samples collected in a few minutes during observed odor events would be expected to have higher values than samples collected over an entire day.

The first three columns of this table summarize a study done at a single site in NW Portland, using EPA equipment and analysis, in 1987-88. The next columns summarize a winter/summer study in which samples were collected at five Portland sites, all of the analyses being done by the DEQ Lab. Also included in this table is a summary of data obtained at a site in a suburban area of Vancouver, Washington as part of EPA's ongoing national Urban Air Toxics Monitoring Program.

All of the pollutants detected in this study were found in at least one of the previous studies, with several common substances (benzene, toluene, xylenes) being frequently found in all three previous studies. Just comparing the last two studies, where the analytical methodology is most similar, it appears that the mean concentrations obtained in Vancouver are often lower than the Bucket sample range. It would not be surprising if this reflects the more urban environment of NW Portland with its higher density of commercial activity and population. However, as we anticipated at the outset, it is most likely due to the shorter sample collection times used with the Buckets. Differences in siting, seasonal variability, and changes in sampling and analytical methodologies make quantitative comparisons impossible, but qualitatively the Bucket VOC results are consistent with data gathered in other studies.

Comparison of the aldehyde and ketone results from this study to previous studies can be more quantitative because the methodologies and sampling intervals used in all the studies were the same. Table 13 provides such a comparison. In this study and the 1987-88 study the sampling location was in NW Portland while in the 1993-94 Portland study the results shown are an overall average for multiple sites located throughout the city. The Vancouver site is located in a residential area quite unlike the urban Portland sites. Still, concentrations of formaldehyde, acetaldehyde and acrolein remain fairly similar across all the studies.

In Table 13 the last columns provide EPA health benchmark values for acute and toxic effects. EPA considers these benchmarks as a concentration below which there should be no public health concern. In this study no single daily value for acrolein approached the acute benchmark, while the mean for methyl ethyl ketone was well below its chronic toxicity benchmark. On the other hand, mean values for formaldehyde and acetaldehyde both exceeded the cancer benchmarks. These results also are very comparable to other studies done in Portland and other urban areas, and warrant concern over a continuing problem. Their presence almost certainly

**Table 12. Comparison of VOC in Other Portland Area Studies**

COMPOUND	1987-88 NW Portland			1993-94 Portland			1997 Vancouver, WA			1997 NW Portland (bucket)		
	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	MDL (ug/m <sup>3</sup> )	# samples	Range (ug/m <sup>3</sup> )
1,3 - Butadiene	0.2	2	4.4		NA		0.3	10	1.9	1	NA	
t - 1,2 - Dichloroethylene	0.2	9	4.0	2.0	ND		0.9	ND		1	ND	0.57 - 0.85
Carbon tetrachloride		NA		3.2	ND		0.4	28	0.5	1	23	
Chloroprene	0.2	5	0.7		NA		0.2	ND		1	NA	
Chloroform	0.0	3	0.5	2.4	ND		0.3	17	0.3	1	2	0.55 - 0.87
Methylene Chloride	0.4	1	0.6	1.8	18	9.3	0.6	17	0.8	1	21	0.99 - 58
Benzene	0.1	26	2.7	1.6	35	3.2	0.8	28	2.0	1	22	0.92 - 7.1
Trichloroethane	0.1	2	6.4	2.7	ND		0.3	ND		1	15	0.73 - 210
1,2 - Dichloropropane	0.2	3	2.3	2.3	ND		0.2	ND		1	ND	
t - 1,2 - Dichloropropylene	0.2	2	1.4		NA		0.4	ND		1	ND	
Toluene	0.1	30	8.8	1.9	82	5.8	0.2	28	5.6	1	22	4.2 - 53
1,1,1-Trichloroethane	0.1	12	1.2	2.7	ND		1.8	ND		1	22	0.85 - 41
Tetrachloroethene	0.5	2	6.1	3.4	ND		0.2	18	0.4	1	16	0.63 - 10
Chlorobenzene	0.1	10	0.8	2.3	ND		0.3	2	0.1	1	ND	
Ethyl Benzene	0.1	11	1.0	2.2	7	4.3	0.3	28	0.6	1	21	0.81 - 4.9
m,p - Xylene	0.1	28	17.2	2.2	48	4.6	0.5	28	2.9	1	22	1.1 - 16
o - Xylene	0.1	22	2.8	2.2	8	4.1	0.3	28	1.0	1	21	0.85 - 5.3
1,1,2,2-Tetrachloroethane	0.1	ND		3.4	2	4.8	1.1	1	0.2	1	ND	
m - Dichlorobenzene	0.1	3	0.4	3.0	2	4.8	0.4	4	0.1	1	ND	
p - Dichlorobenzene	0.1	8	50.0	3.0	2	5.4	0.4	11	0.1	1	ND	
o - Dichlorobenzene	0.1	3	0.5	3.0	2	6.0	0.5	4	0.1	1	ND	
Styrene		NA		2.1	ND		0.3	19	1.4	1	18	0.51 - 53

Notes:

Minimum Detection Limit (MDL) depends on volume of air sampled so this value is approximate.

# samples with detectable amount

ND means Not Detected

NA means Not Available

**Table 13. Comparison of Aldehydes and Ketones in Other Portland Area Studies**

COMPOUND	1987-88 NW Portland			1993-94 Portland			1995 Vancouver, WA			1997 NW Portland			EPA Toxicity benchmarks		
	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	MDL (ug/m <sup>3</sup> )	# samples	Mean (ug/m <sup>3</sup> )	Acute ug/m <sup>3</sup>	Chronic ug/m <sup>3</sup>	Cancer ug/m <sup>3</sup>
Formaldehyde	0.10	27	2.7	0.10	85	2.6	0.01	30	1.6	0.1	13	2.1	NA	3.6	0.07
Acetaldehyde	0.20	26	2.6	0.05	47	2.1	0.02	30	2.2	0.1	12	1.7	NA	9	0.45
Acrolein	0.05	15	0.2	0.10	36	0.8	0.02	21	0.5	0.1	1	0.1	1.2	0.02	2
Acetone		NA		0.05	65	0.9	0.02	22	3.8	0.1	13	1.8	NA	NA	NA
Propanal		NA		0.20	1	1.2	0.02	11	0.7	0.2	10	1.4	NA	NA	NA
Methyl Ethyl Ketone		NA		0.10	26	1.1		NA		0.1	13	1.8	NA	1000	NA
Tolualdehydes		NA		0.10	ND			9	1.3	1	6	1.6	NA	NA	NA
Hexanal		NA		0.10	ND	1	0.05	18	0.4	0.5	1	0.6	NA	NA	NA

Notes:

Minimum Detection Limit (MDL) depends on volume of air sampled so this value is approximate.

# samples with detectable amount

ND means Not Detected

NA means Not Available

Benchmark values from Caldwell, et.al. (1988)

means the public is being exposed to unhealthful levels. Both these pollutants are products of combustion and can be emitted by a variety of sources. In addition, formaldehyde is both removed and formed by atmospheric processes making its control more difficult.

### **Particulate Measurements**

Mass analysis for all particulate samples was done by the ODEQ Laboratory. The results are shown in Appendix H. Metals analyses using X-ray Fluorescence Spectroscopy, the standard Department protocol, were done on PM<sub>2.5</sub> filters collected on 24 July. Additional metal analyses to compare PM<sub>10</sub> and PM<sub>2.5</sub> metal content used a new Inductively Coupled Plasma protocol on filters collected on 15, 24, and 27 July.

#### **1. Mass Concentrations**

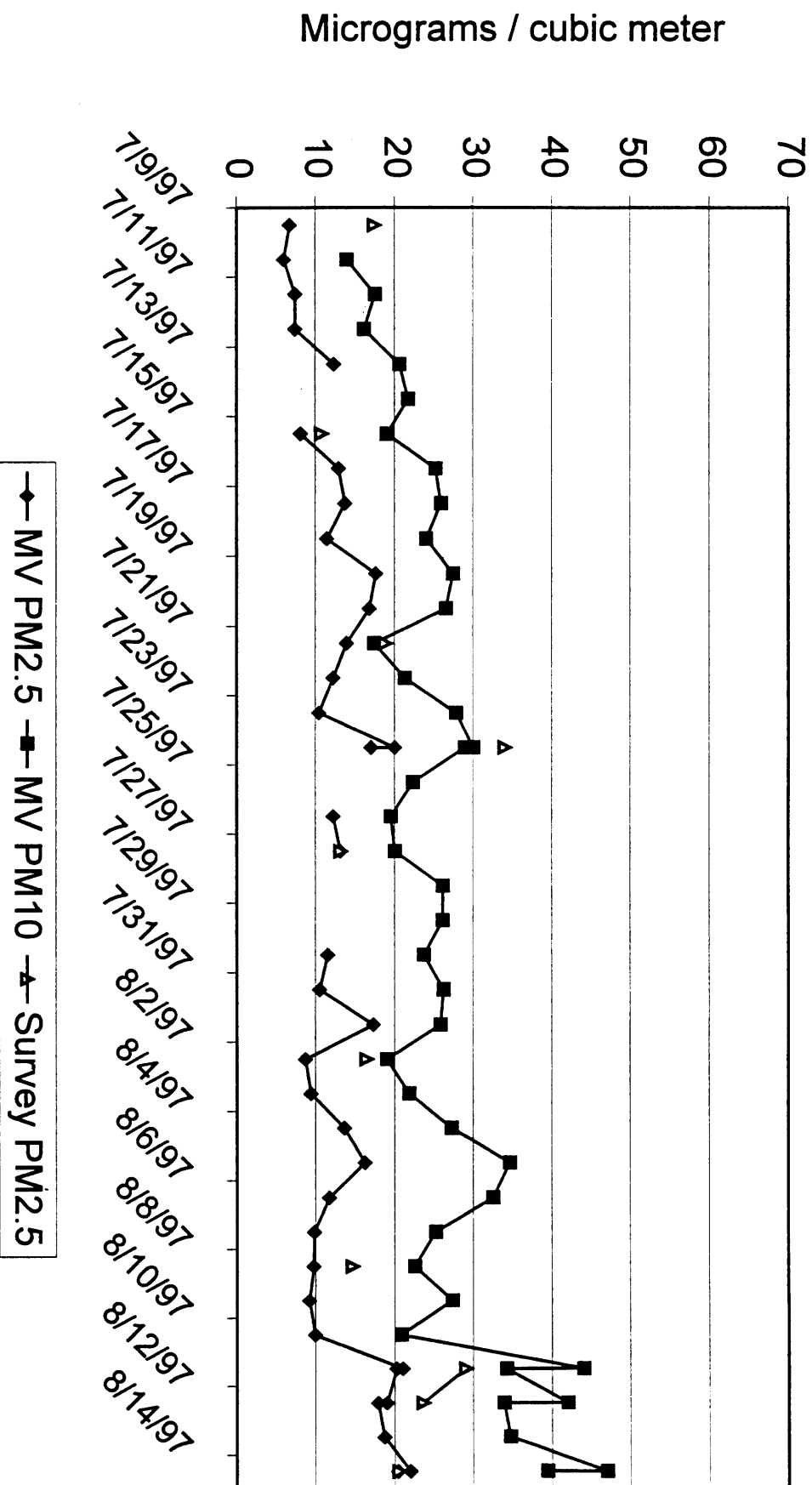
It is important to realize that the technology for PM<sub>2.5</sub> sampling is only now reaching its final stage of refinement. Performance of the equipment used for this study in general seems comparable to Federal Reference Methods (FRM), however there were instances where there were fairly large differences in particulate collection without readily apparent cause. Some of these difficulties are described below.

During Phase I of the study, nine total days were sampled using survey samplers. In addition, the medium volume PM<sub>2.5</sub> and PM<sub>10</sub> samplers ran for the entire month. The 24-hour standard for PM<sub>2.5</sub> is 65 µg/m<sup>3</sup>. The maximum PM<sub>2.5</sub> value of 40.6 µg/m<sup>3</sup> occurred at the Transcon site on 11 August; a Clean Air Action Day called by ODEQ. (Clean Air Action days are called in anticipation of high ozone concentrations.) Clean Air Action days were also called on 12 and 14 August, and 24 July was a forecast day. All of these days were sampled and the highest PM<sub>2.5</sub> levels were seen on these four days. The Transcon site showed the highest daily value most frequently, three out of nine total days sampled. Rover was located at the Aspen site on several occasions and showed two highest daily values. The other sites had one daily high value each.

Figure 1 shows the MV PM<sub>2.5</sub> and PM<sub>10</sub>, and the survey sampler PM<sub>2.5</sub> concentrations for Phase I at the Post Office site. The average concentration for the daily MV PM<sub>2.5</sub> samples collected on Teflon filters at this site was 13 µg/m<sup>3</sup>; close to the annual average standard of 15 µg/m<sup>3</sup>. (The FRM now specifies Teflon filters for collection.)

As a result of observed particulate levels and equipment performance during Phase I, alternative equipment was operated during Phase II. Samplers with a stacked 10/2.5 micron inlet and 15 lpm flow rate replaced the Phase I sampler. Other changes to the equipment (adding rain covers) and handling procedures were made to improve the quality of survey results. After the equipment change, the survey samplers showed consistently lower levels than those produced by the MV with the PM<sub>2.5</sub> inlet.

**Figure 1.**  
**Phase I Post Office Particulate Data**



**Figure 2.**  
**Phase II Post Office Particulate Data**

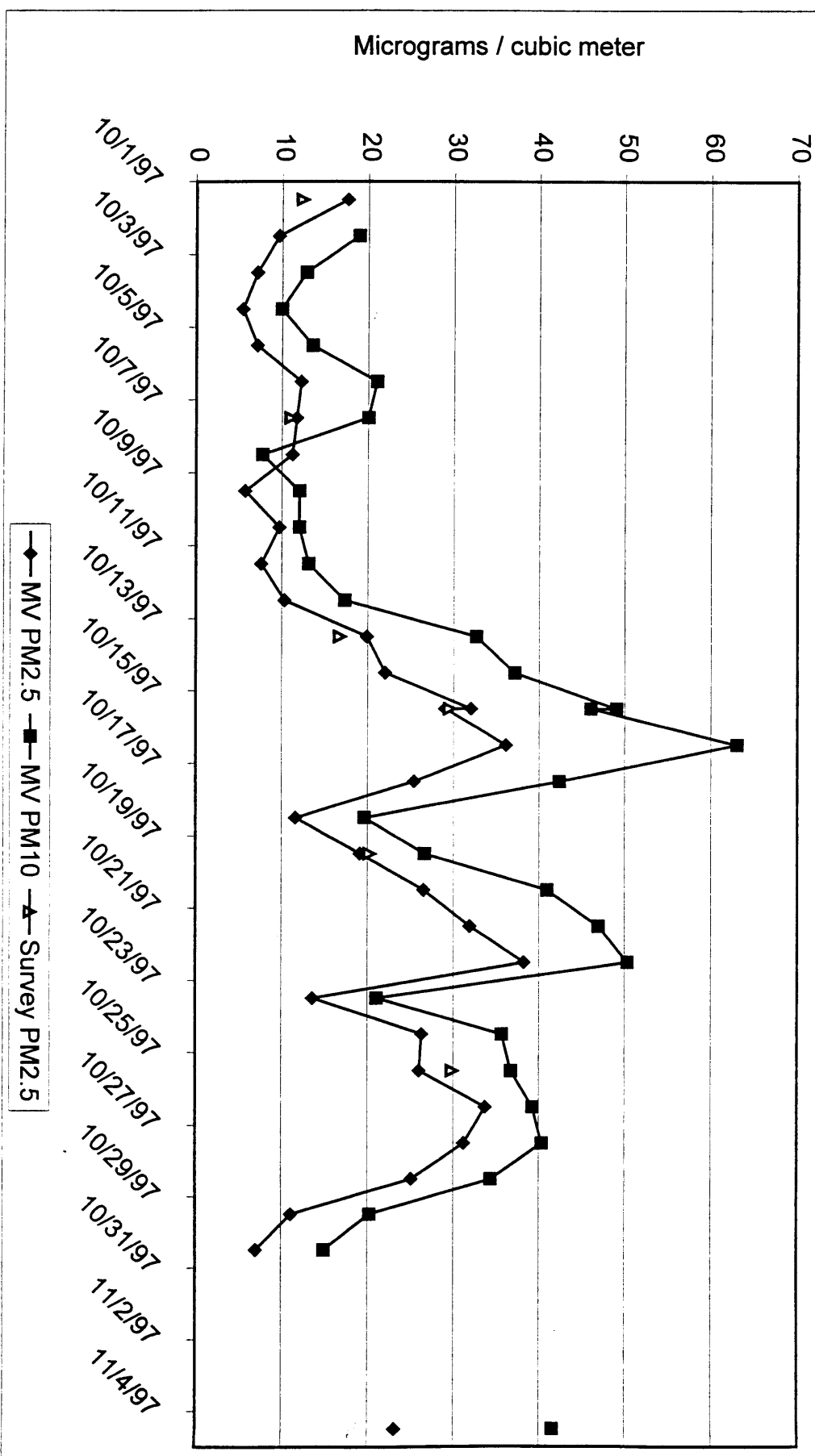
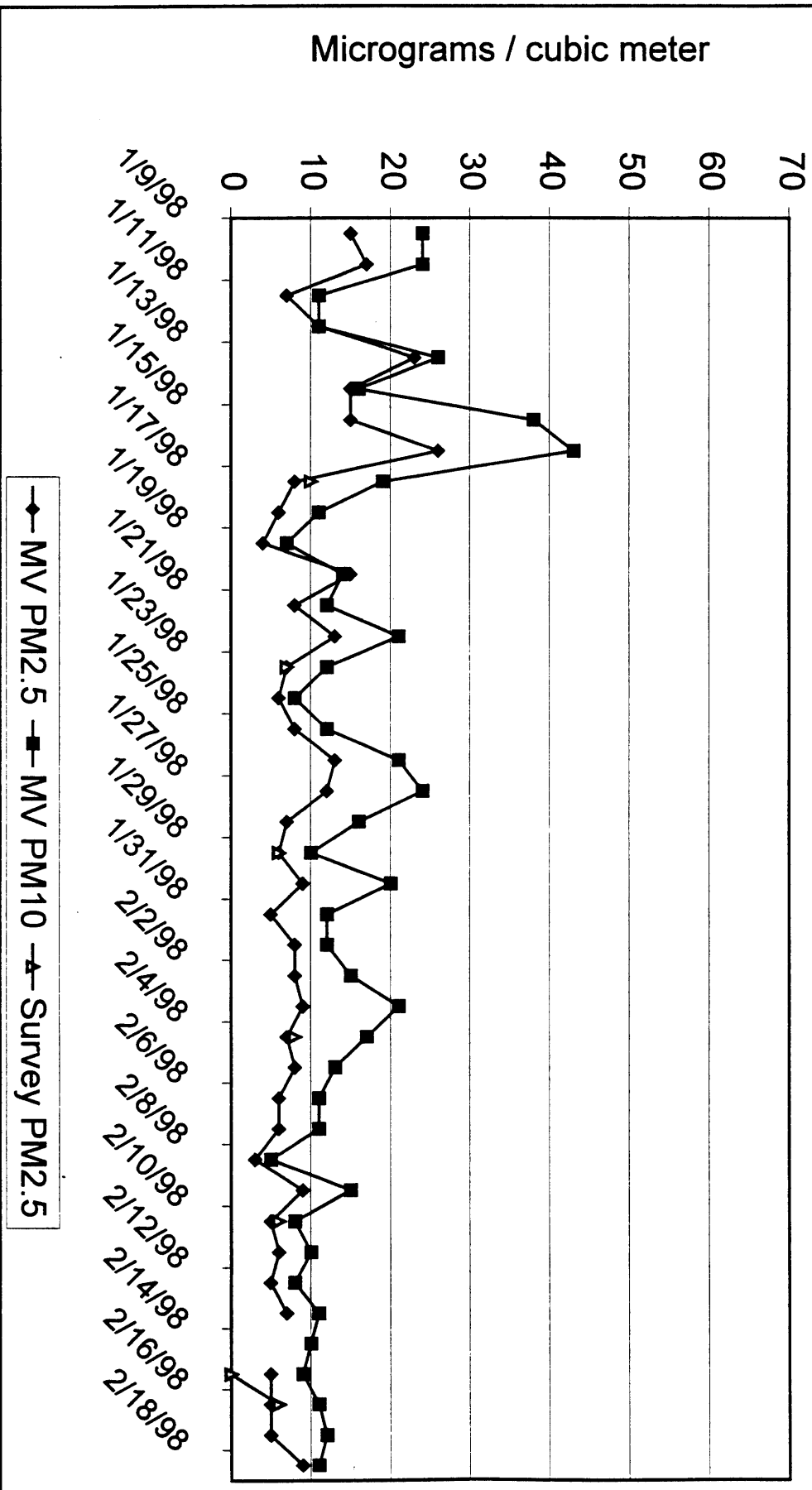


Figure 3.  
Phase III Post Office Particulate Data



During Phase II seven days were sampled on the one in six day schedule. In addition, the medium volume  $PM_{2.5}$  and  $PM_{10}$  samplers ran daily for the entire month. These particulate sample results are shown in Figure 2, along with the survey sampler  $PM_{2.5}$  values. The Post Office showed highest levels overall with five out of seven of the daily highs. Transcon and Chapman each had one daily high. The maximum value from the survey samplers was  $33 \mu\text{g}/\text{m}^3$ . The maximum value from the Post Office MV  $PM_{2.5}$  was  $43 \mu\text{g}/\text{m}^3$ . During Phase II there were two forecast days, 15 October and 4 November. The maximum value observed during this phase occurred on 4 November. The average of the daily medium volume  $PM_{2.5}$  values was  $19 \mu\text{g}/\text{m}^3$  for this sampling phase.

Phase III included 30 continuous days of sampling at the Post Office site with the MV  $PM_{2.5}$  and MV  $PM_{10}$  and one in six day sampling with  $PM_{2.5}$  survey samplers. These results can be seen in Figure 3. During this phase of the study the values were highest at the Post Office four times, and twice each at the Awning and Johnson sites. Overall the concentrations measured in this phase were lower than the previous phases, with a daily average of  $9 \mu\text{g}/\text{m}^3$ .

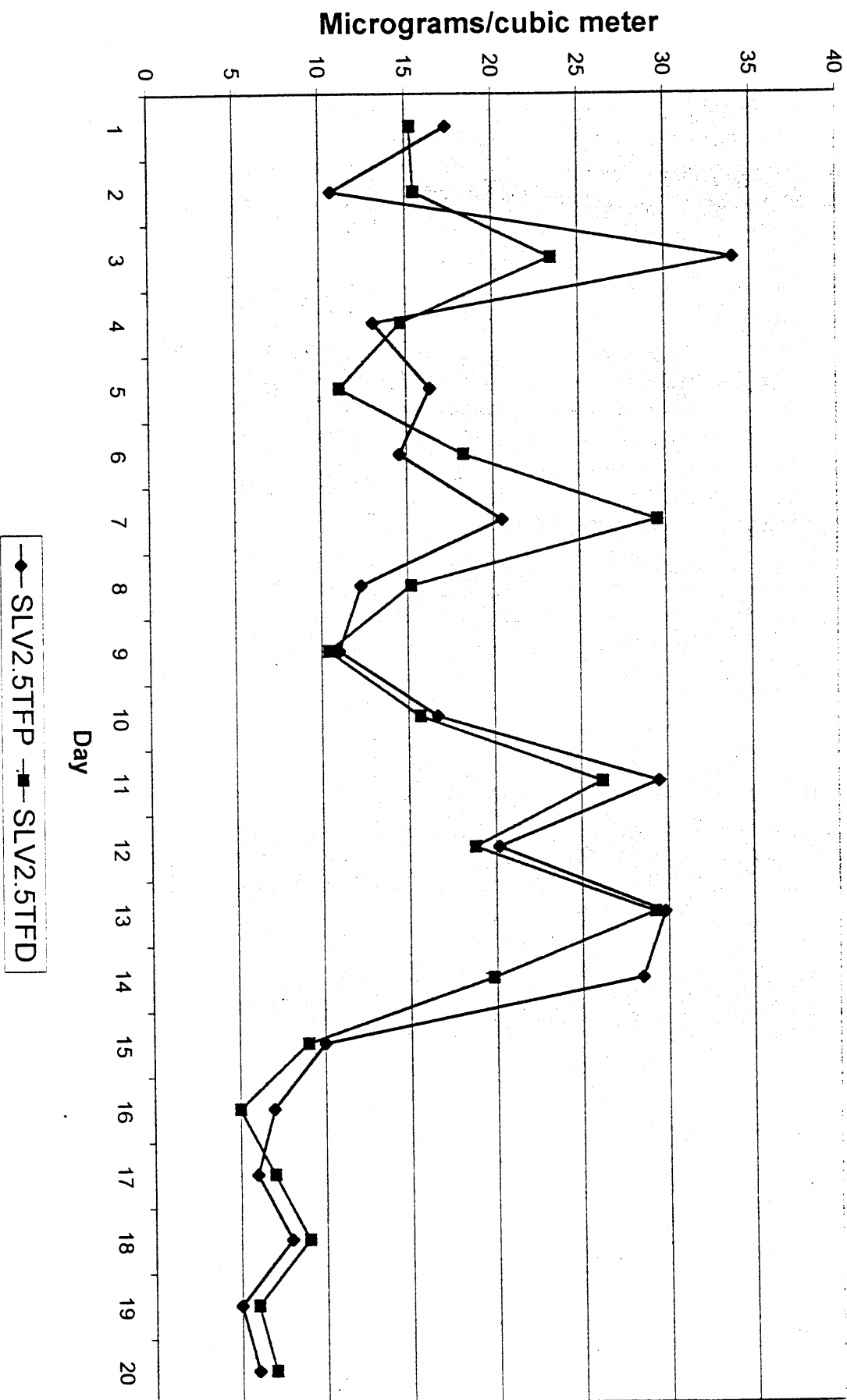
During the study, there were no values of either  $PM_{10}$  or  $PM_{2.5}$  which were 80% or more of the 24-hour standards. Overall 96% of the  $PM_{2.5}$  sample values were less than half the value of the new standard of  $65 \mu\text{g}/\text{m}^3$ . Fifty-three percent of the values were less than a quarter of the standard. All of the highest values recorded occurred on forecast or episode-days. The highest value of  $41 \mu\text{g}/\text{m}^3$  is approximately 63% of the daily standard. Eighty percent of the  $PM_{2.5}$  values were lower than  $PM_{10}$  values by 40%. Twenty percent of the  $PM_{2.5}$  values were greater than 40% of the  $PM_{10}$  values, and of those 11% of  $PM_{2.5}$  values were greater than  $PM_{10}$  (12 of 109 samples). Based on a comparison to the daily standard it looks unlikely that this site exceeds the national  $PM_{2.5}$  standard. On the other hand, the average of the daily values over the entire study was  $14 \mu\text{g}/\text{m}^3$ .

The permanent city-wide  $PM_{10}$  sites were operating on a one in six day schedule during the study period. Out of 14 total sample days the Transcon site had 12 of the daily high values. The second highest value of the day occurred four times at the Roosevelt High School, the Post Office, and the Central Fire Station sites. These sites are located in North Portland, Northwest Portland, and downtown Portland respectively. This comparison again shows that the Transcon site consistently measures the highest values in Portland.

ODEQ operated three survey samplers at the Post Office site, two with 15 liter per minute (lpm) flow and one with 5 lpm flow. The indicated particulate levels from the primary and duplicate 15 lpm samplers were comparable, as shown in Figure 4. A linear regression run on the results from the duplicate samplers yielded  $r^2 = 0.75$ . This shows a good correlation for the pair although in other studies the correlation is usually higher. This study occurred when sampling equipment was in development. The  $PM_{2.5}$  samplers were fairly crude equipment that has not been through rigorous wind tunnel or field-testing. Some refinement of equipment should help to improve this type of sampling in future studies.



# QA Sample Pair



However, the 5 lpm sampler did not track the primary and duplicate results well at all. This sampler was included in this study to verify results of a previous sampler inlet / face velocity investigation. For the most part, sample values were higher than either the primary or duplicate; results consistent with the previous investigation. Subsequent analysis of the particulate confirmed that this inlet did not achieve the desired particle diameter cut-off and was collecting additional particulate of larger size.

## 2. Metal Concentrations

Results of the XRF metals analyses of the particulate filters collected are shown in Table 14. Of the 20 elements routinely measured, fourteen were found on one or more samples. These results are normally used by ODEQ in determining the relative contribution of sources of particulate to an airshed, using a modeling technique called Chemical Mass Balance. There was no intent to do such an analysis with this data, but rather to provide a more qualitative description of the make-up of the particulate in the neighborhood.

Many of these elements, for example aluminum and iron, are common components of soil, however they appear at higher concentrations near the foundry than in other parts of the study area. Not surprisingly, iron, manganese and nickel, which are certainly related to the foundry, can be found in higher concentrations on the particulate samples collected nearest to the foundry. Chromium and copper were only found nearby as well. Silicon, which was higher at Transcon that day, suggests a more traditional impact associated with traffic-generated suspended particulate. On the other hand, aluminum, which is routinely found in traffic impacted samples, was only found near the foundry. Sulfur was the one element that appeared at similar concentrations throughout the study area on that day. Other elements varied, with many having their highest concentrations at the Post Office. It is not clear why the Aspen site showed a relatively high level of iron. Zinc stands out on the Transcon sample although its source is unknown.

With the adoption of the new National Ambient Air Quality Standard for  $PM_{2.5}$ , ODEQ is required to determine if all areas of Oregon meet the standard. It is expected that some will not. In those areas, strategies must be developed to reduce particulate pollution and that will require a firm understanding of the composition of that particulate. A few  $PM_{10}$  and  $PM_{2.5}$  particulate samples, collected in this study, were analyzed by a new technique at the ODEQ laboratory for comparison of elemental composition. This fairly limited data set, shown in Table 15, is consistent with other studies in that it suggests that particulate of different size are likely to have different composition. The new technique, Inductively Coupled Plasma (ICP) analysis, used at the ODEQ Laboratory for the first time on air samples, represents the next generation of elemental analysis of particulate air pollution. It is capable of measuring smaller quantities of more components, more quickly and more economically, providing an improved tool for measuring air pollution in our communities.

**Table 14. PM<sub>2.5</sub> Metals Analyzed by XRF**

SITE	Post Ofc	Post Ofc	Post Ofc	Post Ofc	Post Ofc	Transcon	Aspen	Chapman	Awning	Johnson	Rover	Transcon
DATE	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	7/24/97	8/8/97
TIME	0000-0800	0800-2000	2000-2400	0800-2000	0800-2000	0800-2000	0800-2000	0800-2000	0800-2000	0800-2000	0800-2000	0000-2400
MASS	14	20	14	34	23	31	16	20	25	25	21 est	16
<b>Compounds</b>												
BARIUM	<0.064	<0.050	<0.112	<0.162	<0.161	<0.134	<0.153	<0.157	<0.0123	<0.0137	<0.0134	<0.078
COBALT	<0.009	<0.008	<0.016	<0.012	<0.012	<0.005	<0.009	<0.005	<0.005	<0.006	<0.013	<0.005
PHOSPHORUS	<0.014	<0.012	0.03	<0.031	<0.027	<0.024	<0.029	<0.026	<0.022	<0.025	<0.028	<0.017
SELENIUM	<0.002	<0.001	<0.003	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.003	<0.002
ALUMINUM	0.078	0.082	0.119	0.152	<0.129	<0.097	<0.108	<0.107	<0.091	<0.099	0.216	<0.062
ARSENIC	<0.005	<0.003	<0.007	<0.01	<0.010	<0.008	<0.009	<0.009	<0.007	<0.008	<0.008	<0.004
BROMINE	<0.002	0.002	<0.002	<0.003	<0.003	<0.002	<0.003	<0.003	0.002	<0.002	<0.002	0.002
CALCIUM	0.08	0.057	0.078	0.109	0.104	0.076	0.063	0.059	0.041	0.048	0.088	0.085
CHLORIDE	0.155	0.037	0.083	0.059	<0.047	0.039	<0.034	<0.036	<0.03	<0.034	0.078	0.122
CHROMIUM	0.004	0.006	0.012	<0.008	0.006	<0.004	<0.005	<0.005	<0.003	<0.004	0.008	<0.002
COPPER	0.017	0.012	0.023	<0.024	0.028	<0.021	<0.022	<0.023	<0.02	<0.022	<0.021	<0.011
IRON	0.528	0.505	0.949	0.684	0.686	0.238	0.491	0.258	0.272	0.29	0.74	0.306
LEAD	0.013	<0.008	<0.018	<0.028	<0.032	<0.024	<0.024	<0.026	<0.023	<0.026	<0.023	<0.012
MANGANESE	0.053	0.059	0.066	0.071	0.074	0.018	0.027	0.02	0.022	0.022	0.065	0.015
NICKEL	0.006	0.01	0.008	0.012	0.01	<0.004	<0.005	<0.005	<0.004	<0.007	0.013	<0.003
SILICON	0.286	0.308	0.464	0.496	0.449	0.341	0.166	0.128	0.173	0.121	0.565	0.385
SULFUR	0.633	0.73	0.35	0.781	0.847	0.767	0.728	0.77	0.711	0.671	0.394	0.762
TITANIUM	<0.025	<0.02	<0.044	<0.063	<0.061	<0.051	<0.059	<0.061	<0.047	<0.053	<0.052	<0.031
VANADIUM	<0.010	<0.012	<0.017	<0.025	<0.024	<0.02	<0.023	<0.024	<0.019	<0.021	<0.02	<0.012
ZINC	0.086	0.04	0.061	0.03	0.026	0.12	0.014	0.022	0.0245	0.024	0.025	0.051

all values in ug/m3

Table 15. Comparison of PM<sub>10</sub> and PM<sub>2.5</sub> Metals Analyzed by ICP

CASE: 980233			DATE: 3/19/98			
FUND CODE: 1711			ANALYST: DLL/GDD			
(ONE BLANK)			SIZE:	PM10	PM2.5	PM10
ITEM#:	1	2	3	4	5	6
	Post Ofc	Post Ofc	Post Ofc	Post Ofc	Post Ofc	Post Ofc
	7/15/97	7/15/97	7/24/97	7/24/97	7/27/97	7/27/97
	Q66582	Q66572+	Q66616	Q66620	Q66602	Q66606+
		Q66577	Q66600	Q66621		Q66607
SAMPLE #:			Q66617	Q66614		
ELEMENT	MDL (ug/m3)	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
Aluminum	0.025	0.182	0.120	0.310	0.120	0.216
Antimony	0.0075	<0.0075	<0.0300	<0.0075	<0.0150	<0.0075
Arsenic	0.0050	<0.0050	<0.0200	<0.0050	<0.0100	<0.0050
Barium	0.00025	0.0172	0.0217	0.0341	0.0362	0.00850
Beryllium	0.000025	<0.000025	<0.000100	<0.000025	<0.000050	<0.000025
Boron	0.0075	0.0190	0.0928	0.0157	0.0739	0.0276
Cadmium	0.00025	0.00036	<0.00100	<0.00025	<0.00050	<0.00025
Calcium	0.025	0.355	<0.100	0.422	0.085	0.182
Chromium	0.00050	0.00595	0.00444	0.00704	0.00393	0.00121
Cobalt	0.00050	<0.00050	<0.00200	<0.00050	<0.00100	<0.00050
Copper	0.00075	0.0220	0.0136	0.0203	0.0145	0.00353
Iron	0.0050	0.839	0.601	1.11	0.493	0.361
Lanthanum	0.0025	<0.0025	<0.0100	<0.0025	<0.0050	<0.0025
Lead	0.0075	0.0122	0.0136	0.0115	0.0047	<0.0075
Lithium	0.00100	<0.00100	<0.00400	<0.00100	<0.00200	<0.00100
Magnesium	0.025	0.0668	0.212	0.107	0.023	0.0769
Manganese	0.00050	0.0639	0.0601	0.0772	0.0515	0.0124
Molybdenum	0.00100	0.00550	0.00733	0.00608	0.00196	<0.00100
Nickel	0.00050	0.0151	0.00922	0.0142	0.00542	0.00262
Potassium	0.025	0.184	0.515	0.041	<0.050	0.096
Selenium	0.0075	<0.0075	<0.0300	<0.0075	<0.0150	<0.0075
Silica	0.075	2.20	8.87	5.27	11.8	1.83
Silver	0.00050	<0.00050	<0.00200	<0.00050	<0.00100	<0.00050
Sodium	0.250	0.507	0.938	1.06	1.63	0.622
Strontium	0.000125	0.00165	<0.000500	0.00330	0.00153	0.00113
Thallium	0.0050	<0.0050	<0.0200	<0.0050	<0.0100	<0.0050
Tin	0.0075	<0.0075	<0.0300	<0.0075	<0.0150	0.0162
Titanium	0.00025	0.0191	0.0202	0.0305	0.00552	0.0274
Vanadium	0.00025	0.00139	0.00356	0.00292	0.00171	0.00385
Zinc	0.00125	0.124	0.102	0.0574	0.0719	0.00364
Zirconium	0.00050	0.00339	0.00317	0.00412	0.00328	0.00299

COMMENT 1. Due to digestion in glass containers, data for Boron and Silica may be more variable.

COMMENT 2. Sample and blank filters were digested using the National Ambient Air Quality Standard for lead procedure. The final result was corrected for an average blank filter.

COMMENT 3. To calculate ug%: 100 x (ug/m3)/(Loading (ug/m3)).

COMMENT 4. MDL(ug/m3) was calculated using data from MDL determinations for aqueous samples. They will vary depending on the air sample volume.

## CONCLUSIONS

### Odor

Use of the Odor Survey Forms helped neighbors distinguish between sources, since Northwest Portland residents described a number of distinct odors. Heightened awareness of the various odors resulted in better observations of their likely sources, which, in turn, has helped the Department to work with some of the sources to reduce their neighborhood impact.

Publicity that this study has received has brought the odor issue to the forefront of neighborhood discussions and has also demonstrated that air pollution problems such as these can sometimes be resolved with good faith efforts. Changes in ventilation engineering and in chemical use have improved the situation near the electric motor repair shop. The foundry has investigated their processes and chemical use and has made a concerted effort to identify the compounds responsible for the odors. They have begun using a chemical scrubbing technique on airstreams from certain parts of their facility in an effort to reduce their odor impact (Appendix I - 30 June 1997 letter from J. Carter Webb, ESCO to Frank Bird, NWDA).

### Organic Compounds

Odor impacts in the study area were the major impetus for this investigation and our primary objective was to determine the chemicals in air samples associated with odors. Neighbors were able to collect about a dozen samples for VOC analysis during odor episodes. Those samples, along with other gas samples taken by ODEQ measured twenty-seven different volatile organic compounds, 9 semi-volatile organics, and 8 carbonyl compounds.

Styrene, clearly found at higher concentration in three samples collected at one site, led directly to a nearby business using this chemical; exactly the type of situation we had hoped to find. The ODEQ Northwest Region office provided technical assistance to the company in an effort to eliminate its emissions of this particularly odorous chemical (see Appendix J). However, identification of this source turned out to be a special circumstance in this study.

Bucket sampling during nine other odor events failed to identify any compounds that were sufficiently unique to lead to a specific source. Most of these chemicals are frequently identified in urban areas and could have had their origin from any number of emissions sources common in the area. A few industrial solvents, commonly used but not commonly measured in other studies, were identified in Northwest Portland but their odors were not distinctive enough to trace to a specific source.

It was stated at the outset that this study would have limited value in assessing the health impact of the ambient concentrations of HAP, or other organics, measured in the neighborhood. The short-term episode samples did not demonstrate any danger of acute exposures for the public and they cannot be used to estimate the health effects of any longer term exposures.

In contrast to the VOC, the other organics measured with the cartridges and PUFs over longer sampling times provided data on pollutants present in urban air that may be assessed for chronic public exposures. Formaldehyde and acetaldehyde were routinely measured at levels that warrant concern, although similar concentrations are found in many urban areas. Some of the aldehydes found and quantified had not been measured in other studies, while most were consistent with earlier data. The semi-volatile organics concentration data provides some of the first ambient measurements of these compounds in Portland, as well as other urban areas. Our ability to now measure these significant pollutants at these low levels offers improving opportunities to track their presence and monitor changes in their concentrations over time.

Overall, the unusual results obtained from the ODEQ canister samples and VOC analyses were problematic for several reasons:

1. Since compounds were found that no other studies have mentioned it is impossible to tell without further monitoring whether these compounds are unique to the Portland airshed and deserving of our attention, or simply indicative of analytical anomalies.
2. We were unable to relate the 24-hour concentrations measured in this study to other studies in a meaningful way.
3. We were unable to make adequate comparisons of concentrations measured during odor episodes with 24-hour concentrations reducing our ability to provide quality assurance for the Bucket samplers.

Still, this study, when coupled with the other studies the Department has done in the Portland airshed, helps to give a more complete picture of HAP concentrations in Northwest Portland.

### **Particulate**

A secondary objective of this study was to begin gathering data that could be used in determining Portland's attainment status with respect to the new fine particulate ( $PM_{2.5}$ ) standard. As mentioned earlier, the new fine particulate sampling methods were still undergoing development during this project. Our experiences uncovered some problems that were later addressed. Despite the problems our results provided sufficient information to assist the Department in establishing Portland-area sites for the new fine particulate standard attainment determination.

There was sometimes a substantial difference in  $PM_{2.5}$  loading between the teflon and quartz filters which were collected simultaneously with the MV. The differences between teflon and quartz has been noted in  $PM_{10}$  sampling as well. On several occasions the differences were greater than 50%. These large differences occurred when loading was light and the effect of the differences is exaggerated. In addition, there were days when the indicated  $PM_{2.5}$  levels were higher (by  $1 \mu g/m^3$ ) than  $PM_{10}$  at the Post Office where the samplers were co-located. Since there was no reference method available for performance comparison, reasons for these results remain speculation. It could be that all of the suspended particulate on those days was  $PM_{2.5}$  or smaller, or that the inlet could be missing the finer size cut. A Federal Reference Method

sampler was operating at the SE Lafayette air monitoring site in Portland during this study period and showed the same results, i.e. that the  $PM_{2.5}$  was greater than the  $PM_{10}$ . This reinforces the idea that all of the particulate (during that time) was  $PM_{2.5}$  or smaller.

In view of the upcoming implementation of the new  $PM_{2.5}$  standard, the information from this study is helpful in determining relative concentrations of  $PM_{2.5}$  in Northwest Portland. This information will be useful for future siting determinations. The permanent Transcon site showed highest  $PM_{10}$  values most of the time during this study. This site is a maximum impact site for the city, however it is probably not representative of a population exposure site since it is located in the industrial area. Assuming that there is still interest in maximum  $PM_{10}$  impacts, the Transcon site has been confirmed as one of the highest in the city. A maximum population exposure  $PM_{2.5}$  site should be established near the Post Office located at NW 24<sup>th</sup> and Savier since the average level measured over the 3 month study period was very close to the annual average standard.

Twenty-three metals were measured in the particulate samples analyzed. Many of the elements were exclusively found at the site nearest the foundry, or had their highest concentration there. Since only two sample days were analyzed, and since some of the metals are listed HAP, it is clear that additional quantification of toxic metal concentrations is needed to assess health impacts.

## **RECOMMENDATIONS**

### **Odor**

The proximity of the residential area to the assortment of industrial and commercial businesses using coating and cleaning chemicals in Northwest Portland poses a difficult situation for identifying odor sources. In other parts of the state odors are often easily identified because they are unique and/or the potential sources are limited. We recommend that residents of Northwest Portland continue to fill out odor forms so they can provide the Department with evidence of whether odor problems are being resolved. It is clear that considerably more work will be needed to reduce the odor nuisances in this particular neighborhood.

### **Organic Compounds**

During one odor event fourteen chemicals were identified and a subsequent 24-hour sample turned up the same components. Some of these compounds are fairly unique to specific sources, while others can be released from several different processes. These results in particular demonstrate the difficulty of establishing a pollutant source where numerous industrial processes can be contributing to an air mass as it moves downwind. A detailed emissions inventory of the area coupled with this ambient air data is a necessity for pinpointing the source of these pollutants.

Our experience in this study highlights the technical difficulties of doing analyses of environmental contaminants at these low concentrations. It is simply hard to put the sampling and analytical systems together to achieve scientifically credible results without considerable experience using the methodology. ODEQ must establish an ongoing ambient HAP monitoring program in order for the laboratory to develop and maintain its ability to support these environmental measurements.

This study demonstrated that Bucket sampling, with the help of neighborhood volunteers, is a valuable way to gather air quality information. The VOC analysis of these samples resulted in very credible ambient air data and indicates that interested citizens can greatly enhance the Department's ability to measure HAP throughout the state. Citizens were able to learn first-hand what was in the air they breathe. We think that ultimately this way of involving neighbors can also be a valuable tool in helping local people gain a better understanding of what is in their air and of the sources of air pollution in their communities.

### **Particulate**

Generally pollutant buildup occurs under conditions of stagnation, which include a low mixing height, stable air mass, and very low wind speeds. Highest levels of  $PM_{2.5}$  occurred on days that were either episode or forecast days—those days during which meteorological conditions are most conducive to pollution buildup. Although highest days occurred under these conditions, no value threatened the new standard of  $65 \mu\text{g}/\text{m}^3$ . However, with regard to the annual standard of  $15 \mu\text{g}/\text{m}^3$ , the average of the Teflon filters from the MV sampler was  $13 \mu\text{g}/\text{m}^3$ , and the average for the quartz filters from the MV was  $17 \mu\text{g}/\text{m}^3$ . Additional study of the area using FRM samplers is indicated and it is recommended that one of the future  $PM_{2.5}$  core sites for Portland is located in the Northwest Portland area to gather year-round data. Further, it is recommended that metal analyses be done on samples collected at this site on a regular basis in order to estimate potential HAP metal exposures in the neighborhood.



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## APPENDIX A

### Analytical Methods and Compounds

VOLATILE ORGANIC COMPOUNDS  
METHOD TO-14

<u>COMPOUND</u>	<u>CAS#</u>
Acrolein (2-Propenal)	107028
1,1-Dichloroethylene-	75354
Methylene Chloride	75092
trans-1,2-Dichloroethylene-	156605
1,1-Dichloroethane -	75343
2,2-Dichloropropane	594207
cis-1,2-Dichloroethylene -	156694
2-Butanone (MEK)	78933
Bromochloromethane -	74975
Chloroform	67663
1,1,1-Trichloroethane -	71556
Carbon Tetrachloride	56235
Benzene	71432
1,2-Dichloroethane	107062
Trichloroethylene	79016
1,2-Dichloropropane	78875
Bromodichloromethane	75274
2-Chloroethyl Vinyl Ether	110758
cis-1,3-Dichloropropene	10061015
4-Methyl-2-Pentanone (MIBK)	108101
Toluene	108883
trans-1,3-Dichloropropene	10061026
1,1,2-Trichloroethane	79005
1, 1,2,2-Tetrachloroethylene	127184
1,3-Dichloropropane	142289
Dibromochloromethane	124481
1,2-Dibromoethane (EDB)	106934
Chlorobenzene	108907
1,3-Butadiene	106990
Trichlorotrifluoroethane	7613
Carbon Disulfide	75150
Methyl-tert-Butyl Ether	1634044

<u>COMPOUND</u>	<u>CAS#</u>
Ethyl Benzene	100414
1,4/1,3-Dimethylbenzene -	106423/108383
1,2-Dimethylbenzene -	95476
Styrene	100425
Bromoform	75252
Bromobenzene-	108861
1,1,2,2-Tetrachloroethane	79345
n-Propylbenzene -	103651
2-Chlorotoluene -	95498
4-Chlorotoluene -	106434
1,2,4-Trimethylbenzene -	95636
1,3-Dichlorobenzene -	541731
4-Isopropyltoluene -	99876
1,4-Dichlorobenzene	95501
1,2-Dichlorobenzene	106467
n-Butylbenzene	104518
1,2,4-Trichlorobenzene	120821
Hexachloro-1,3-Butadiene	87683
1,1-Dichloropropane	563586
Dibromomethane	74953
1,1,1,2-Tetrachloroethane	630206
Isopropylbenzene	9882a
1,3,5-Trimethylbenzene	108678
sec-Butylbenzene	135988
tert-Butylbenzene	98066
1,2-Dibromo-3-chloropropane	96128
Naphthalene	91203
1,2,3-Trichlorobenzene	87616
2-Hexanone	591786
Acetone	67641
Vinyl Acetate	108054

ALDEHYDES AND KETONES  
METHOD TO - 11

<u>Compound</u>	<u>CAS #</u>
Formaldehyde	50000
Acetaldehyde	75070
Acrolein	107028
Acetone	67641
Propanal	123386
Crotonaldehyde	123739
Methyl Ethyl Ketone	78933
Isobutyraldehyde	78842
Benzaldehyde	100527
o-Tolualdehyde	110623
Pentanal	529204
p-Tolualdehyde	620235
m-Tolualdehyde	104870
Hexanal	66251

SEMI-VOLATILE ORGANIC COMPOUNDS  
NPDES METHOD 625 AND RCRA SW846 METHOD 8270B

<u>Compound</u>	<u>CAS #</u>	<u>Compound</u>	<u>CAS #</u>
Phenol	108952	4,6-Dinitro-2-methylphenol	534521
Bis(2-chloroethyl)ether	111444	N-Nitrosodiphenylamine	86306
2-Chlorophenol	95578	4-Bromophenylphenylether	101553
1,3-Dichlorobenzene	541731	alpha-BHC	319846
1,4-Dichlorobenzene	106467	Hexachlorobenzene	118741
1,2-Dichlorobenzene	95501	Pentachlorophenol	87865
Bis(2-chloroisopropyl)ether	39638329	beta-BHC	319857
2-Methylphenol	95487	gamma-BHC (Lindane)	58899
Hexachloroethane	67721	Phenanthrene	85018
N-Nitroso-di-n-propylamine	621647	Anthracene	120127
4-Methylphenol	106445	delta-BHC	319868
Nitrobenzene	98953	Heptachlor	76448
Isophorone	78591	di-n-Butylphthalate	84742
2-Nitrophenol	88755	Aldrin	309002
2,4-Dimethylphenol	105679	Heptachlor epoxide	1024573
Bis(2-chloroethoxy)methane	111911	Fluoranthene	206440
2,4-Dichlorophenol	120832	Pyrene	129000
1,2,4-Trichlorobenzene	120821	Endosulfan I	959988
Naphthalene	91203	trans-Nonachlor	39765805
2,6-Dichlorophenol	87650	Dieldrin	60571
Hexachlorobutadiene	87683	p,p'-DDE	72559
4-Chloro-3-methylphenol	59507	Endrin	72208
1,2,4,5-Tetrachlorobenzene	95943	Endosulfan II	33213659
Hexachlorocyclopentadiene	77474	p,p'-DDD	72548
2,4,6-Trichlorophenol	88062	Butylbenzylphthalate	85687
2,4,5-Trichlorophenol	95954	Endosulfan cyclic sulfate	1031078
2-Chloronaphthalene	91587	p,p'-DDT	50293
Acenaphthylene	208968	Bis(2-ethylhexyl)adipate	103231
Dimethylphthalate	131113	Benzo(a)anthracene	56553
2,6-Dinitrotoluene	606202	Chrysene	218019
Acenaphthene	83329	Bis(2-ethylhexyl)phthalate	117817
2,4-Dinitrophenol	51285	Di-n-octylphthalate	117840
Dibenzofuran	132649	Benzo(b)fluoranthene	205992
2,4-Dinitrotoluene	121142	Benzo(k)fluoranthene	207089
2,3,5,6-Tetrachlorophenol	935955	Benzo(a)pyrene	50328
2,3,4,6-Tetrachlorophenol	58902	Indeno(1,2,3-cd)pyrene	193395
Fluorene	86737	Dibenzo(a,h)anthracene	53703
Diethylphthalate	84662	Benzo(g,h,i)perylene	191242

## APPENDIX B

### Study Area Map and Site Photographs

# NWPDX Toxics/Odor Survey 1997-98



**NW PORTLAND TOXICS/VOC MONITORING PROJECT  
1997-98 SITE PHOTO DOCUMENTATION**



**Forest Park Post Office  
Benchmark site Phase I, III**



**Forest Park Post Office  
Sampler relocated 100' N. Phase II**



**Transcon Trucking Terminal  
PM10 Routine SLAMS  
Ambient sampling station  
Phase I, II, III**



**Aspen  
Neighborhood background site  
Phase I, II, III**



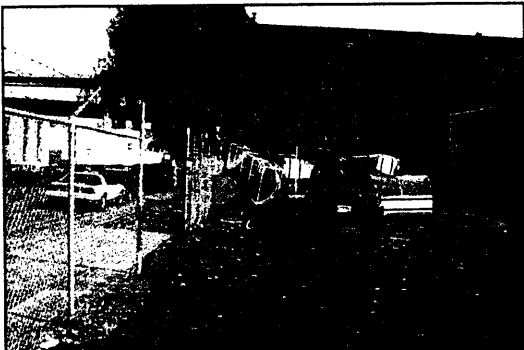
**NW PORTLAND TOXICS/VOC MONITORING PROJECT  
1997-98 SITE PHOTO DOCUMENTATION**



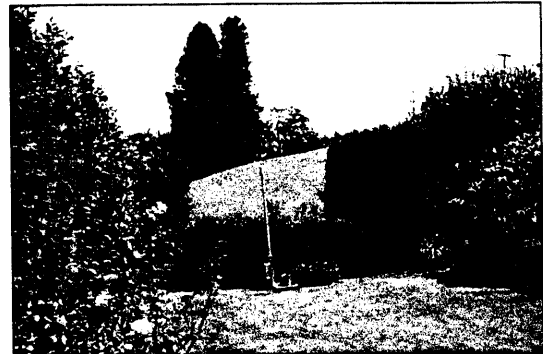
**NW 22<sup>nd</sup> & Johnson  
High density residential  
Phase I**



**NW 23<sup>rd</sup> & Johnson  
High density residential  
Phase II & III**



**NW Awning  
Transportation oriented impacts  
Phase I, II, III**



**NW Chapman  
School zone/neighborhood  
Phase I, II, III**

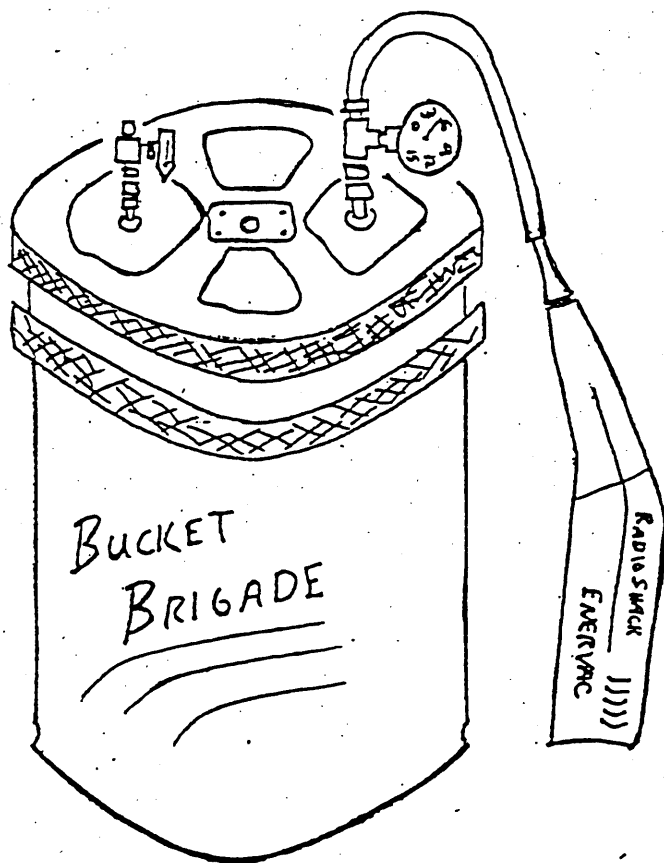
## APPENDIX C

### Description of Bucket Sampler

*Community - Based Air Sampling*

# **BRING ON THE BUCKET BRIGADE!**

**How to Make and Use  
Your Own Air Sampling Equipment**



by Jeff Hobson  
for the National Oil Refinery ACTION! Network,  
a project of Communities for a Better Environment  
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First Edition September 1996

## APPENDIX D

### Complete Bucket Sampler Results

Site		Post Off.	Post Off.	Post Off.	Blank	Post Off.	Post Off.	Post Off.	Post Off.	Post Off.	Sample	Sample	Overl	Avnng	Trans	Trans	Savlr	Savlr
Budget ID		PDX-11-3	50370	PDX-11-6	PDX-11-2	PDX-11-4	50309	PDX-11-5			P2-1	P5-1	P4-1	P4-2	P7-4	PD7-4	P6-1	P06-1
Date Sampled		4-Nov	4-Nov	4-Nov	4-Nov	4-Nov	4-Nov	4-Nov			15-Oct	15-Oct	15-Oct	16-Oct	16-Oct	16-Oct	15-Oct	15-Oct
Time of Day Sampled		1000	1000			1005	1005				2:20	2:22	1:40	2:39	2:22	2:22	1:40	1:40
Date Analyzed		5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov			16-Oct	16-Oct	16-Oct	17-Oct	17-Oct	17-Oct	16-Oct	16-Oct
Compounds	CAS #	purged	summa	purged	purged	purged	summa	purged	summa	purged	not purged	purged	purged	purged	purged	purged	purged	purged
Chloromethane	74-87-3	1.6	2.3	1.5		1.6	2.5	1.7			1.5	1.5	1.4	1.7	1.4	1.5	1.5	1.5
Vinyl chloride	75-01-4																	
bromomethane	74-83-9																	
chloroethane	75-00-3																	
acetalone	67-64-1	14	6.5	14	6.6	9.4	7.6	15	20	7.2	22	22	54	21	20	20	18	19
trichlorofluoromethane	75-69-4	2.4	1.7	2.4		2.3	1.9	2.4	1.6	1.6	2.6	2.6	2.1	1.9	2.1	2.1	1.8	1.8
1,1-dichloroethane	73-35-4																	
methylene chloride	75-09-2	33	2.1	55	32	27	1.2	58		0.98r	5.4	2.2	2.2	2.2	2.2	2.2	1.5	1.6
trichlorofluoroethane	76-13-1	0.72lr		0.73lr	0.61lr	0.74lr	0.9lr	2.6	0.84lr	1	1.2	0.82lr	0.82lr	0.72lr	0.82lr	0.82lr	1	0.91lr
carbon disulfide	75-15-0	1.6		2.2	2.2	1.8		0.74lr	5.8	1.4	1.9	1.2	1.2	1.7	1.7	1.7	1.6	2.2
trans-1,2-dichloroethane	158-60-5																	
1,1-dichloroethane	75-34-3																	
methyl tert-butyl ether	1634-04-4													2.4				
2-butanone (Methyl Ethyl Ke	78-93-3	2.5	2.7	2.6	1.1	1.8	2.1	2.3	9	2.3	6.4	14	9.7	10	10	10	9.7	9.8
cis-1,2-dichloroethane	158-59-2													0.55lr				
chloroform	67-66-3																	
1,2-dichloroethane	107-06-2																	
1,1,1-trichloroethane	71-55-6	.85lr		1.1		0.96lr	0.74lr	0.93lr	1.1	1.5	3.1	4.1	0.97lr	0.88lr	0.78lr	0.78lr	0.83	0.83
benzene	71-43-2	6.6	4.8	4.6		4	4.2	4.3	0.77lr	0.92lr	1.7	7.1	6.7	6.6	6.6	2.7	2.6	2.6
carbon tetrachloride	56-23-5	0.7lr		0.76lr		0.73lr	0.57lr	0.76lr	0.61lr	0.61lr	0.62lr	0.78lr	0.69lr	0.66lr	0.66lr	0.60lr	0.65lr	0.65lr
1,2-dichloropropane	78-87-5																	
bromodichloromethane	75-27-4				18													
trichloroethene	79-01-6	.99lr									0.83lr	210	2.6	2.3	2.3	0.81lr	0.78lr	0.78lr
cis-1,3-dichloropropene	0061-01-1																	
4-methyl-2-pentanone (meth	106-10-1																	
trans-1,3-dichloropropene	0061-02-6																	
1,1,2-trichloroethane	79-00-5																	
toluene	106-88-3	23	14	16	3.9	15	12	17	4.6	4.2	7.7	48	22	22	22	13	13	13
2-hexanone	591-78-6																	
dibromochloromethane	124-48-1																	
1,2-dibromomethane	106-93-4																	
tetrachloroethane	127-18-4	3.3	5.1	8.2	2.8	5.2	6.6	10	0.82lr		2.5	1.3	1.2					
chlorobenzene	106-90-7																	
ethylbenzene	100-41-4	3.3	2.4	2.1		1.7	1.8	1.7	1.3	1.1	1.2	4.9	4.8	4.7	4.7	3.3	3.3	3.3
m- & p-xylene	1330-20-7	13	8.9	7.1	0.65lr	6.2	6.7	5.9			3.6	14	16	16	16	11	11	11
bromoforn	75-25-2																	
styrene	100-42-5	0.73lr		0.73lr				0.68lr	.60lr		0.51lr	2.1	5.3	5.3	5.3	3.3	3.2	3.2
o-xylene	95-47-6	4.4	3.1	2.4		2.1	2.4	2			1.2	4.9						
1,1,2,2-tetrachloroethane	79-34-5																	
1,3-dichlorobenzene	541-73-1																	
1,4-dichlorobenzene	106-46-7																	
1,2-dichlorobenzene	85-50-1																	



Sheet1

Site		Post Off.	Post Off.	Post Off.	Blank	Post Off.	Post Off.
Bucket ID		PDX-11-3	50370	PDX-11-6	PDX-11-2	PDX-11-4	50309
Date Sampled		4-Nov	4-Nov	4-Nov	4-Nov	4-Nov	4-Nov
Time of Day Sampled		1000	1000			1045	1045
Date Analyzed		5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov
Compounds	CAS #	purged	summa	purged	purged	purged	summa
Tentatively I.D.d compds							
carbonyl sulfide + propane		20		10		10	
carbonyl sulfide							
Dichlorodifluoromethane			6				4
propane			7				4
acetaldehyde + isobutane							
acetaldehyde	75-07-0				20		
isobutane		20	9	30		20	10
fluorotrimethylsilane							
butane		70		50		50	
n-butane			20				20
ethanol		30	20	10	10	20	200
isopentane			20				10
isopropanol			10				
unidentified chlorofluorocarbon							
2-methylbutane		50		40	4	40	
isopropyl alcohol					4		
pentane		30		20		20	
n-pentane			6				6
trimethylsilanol							
Methylcyclobutane + C6 Branched Alkane							
2-Methylpentane		20	4	20		20	4
3-Methylpentane		3					2
n-hexane		5					
hexene							
tetrahydrofuran							
Methylcyclopentane		7	3	5		5	3
Methyl Methacrylate							
1-butanol							
3-Methylhexane							
Hexanal							
n-Octane			3				
C9H20 branched alkane							
Octane						6	
hexamethylcyclotrisiloxane							
C9H20 branched alkane							
C9 branched alkane				5	2		
N,N-Dimethyl Acetamide (possible artifact)							
decane		2					
C9 branched alkane				6	3		
C9H20 branched alkane							

C9H20 branched alkane						
unidentified silane or siloxane					4	
n-Decane						
Phenol (possible artifact)						
1-octanol						
C12H26 branched alkane						
unidentified Silane or Siloxane						
n-undecane						
C12H26 branched alkane						
C12H26 branched alkane						
3-ethyltoluene			4			3
1,2,4-Trimethylbenzene	5	5			2	4
6-Methyl-5-hepten-2-one						
Decane					2	
C10H20Alkene						
C11-H24 Branched Alkane						
unidentified silane or siloxane						
Octanal						
n-Decane	3					
d-limonene						
1-Octanol						
C12 Branched Alkane	7		7		5	
C13 branched alkane				4		
C13H28 branched alkane						
Nonanal						
C12H26+A103 Branched Alkane						
n-Undecane						
Undecane			3			
C8-C9 aldehyde+C10H14 Alkyl substituted benzene						
C12branched alkane			10			
C13 branched alkane						
C13-C14 branched alkane			5	3		
unidentified silane or siloxane					10	
Cyclohexyl Isothiocyanate						
Octyl Acetate						
dodecane			2			
C14-C15 branched alkane						
C14 branched alkane						



Sheet1

Post Off.	Sauvie	Sauvie	Overl	Awning	Trans	Trans	Savier	Savier
PDX-11-5	P2-1	P5-1	P4-1	P4-2	P7-4	PD7-4	P6-1	PD6-1
4-Nov	15-Oct	15-Oct	15-Oct	16-Oct	16-Oct	16-Oct	15-Oct	15-Oct
	2:20	2:22	1:40	2:39	2:22	2:22	1:40	1:40
5-Nov	16-Oct	16-Oct	16-Oct	17-Oct	17-Oct	17-Oct	16-Oct	16-Oct
purged	not purged	purged	purged	purged	purged	purged	purged	purged
10	6	1		40	30	20		
		3						
20				100	40	40	4	5
60				200	200	200		
			4				20	20
30		7	20		20	20	20	20
			4				10	10
	8	1						
40				300	100	100		
				30	8	7		
20				900	60	60		
							6	6
	8		3					
				20				
20				30	30	9	4	4
				10	9	9		
4								
				10	9	9		
	8		5					
5				10	10	10		
	8		4				4	4
							3	3
					6	6		
		2						
	20	2	7				3	4
	10	4	10				10	10
6								
		3						
9								
	4							

Sheet1

	4						
		6				8	
				10	9	10	
	20					10	
		6		9			
	5						
						4	4
				6	4	4	
	9	4	10				
				9			
			3				
	60	3	20			8	5
		2					
	20		10				8
			2				
			10				10
	9				6	7	
		4					
			3				
	3			10			
	10						
	20						
		4				4	3

Sheet1

Dover	Dover	Davies	Dover	Dover	Dover	Dover	Dover	Dover
P3-1	P8-1	P5-1	P9-1	PD9-1	P7-1	P7-2	P9-2	P5-3
15-Oct	16-Jul	21-Jul	22-Jul	22-Jul	22-Jul	24-Jul	28-Jul	30-Jul
1:50	10:45	7:35	11:30	11:30	13:42	10:00	10:00	9:22
16-Oct	17-Jul	22-Jul	23-Jul	23-Jul	23-Jul	26-Jul	29-Jul	31-Jul
purged	not purged	not purged	not purged	not purged	not purged	not purged	not purged	not purged
	ug/m3							
						10	40	10
	5	10	20	10	10			
	10							
						10	9	
20								
		5						
20								
50					90	20	20	
100	9	7						
30	40		20	20				
		4						
					10	20	10	20
					30	20	70	20
			20	20	20	9	10	10
50								
		20						
9	10	5	20	20	10	10	10	10
30	4	5	7	8				
9								
8								
		8			6		2	4
	10				7	7	9	
			8	8				
	10	6	10	10		7		
			10	10			8	10
							80	60
			5	5			3	
								9

## Sheet1

		30	8	7	10	4	
		6			7	3	6
			10	20	7		5
	10	10					
	20	7	10	9			
	6						
	20	8	10	10	8		10
9	7						10
8							
20	30	10	10	10			6
30							
						4	3
						9	7
	8						
8							
					7		
					9	10	8
	20				6	20	20
			6	6			

Sheet1

Orton	Davies	Davies	Orton	Dover	Dover	Orton	Orton
P1-1	P8-2	PD8-2	P8-3	P5-4	PD5-4	P7-3	PD7-3
30-Jul	30-Jul	30-Jul	6-Aug	11-Aug	11-Aug	19-Aug	19-Aug
	13:33	13:33	14:40	15:20	15:20	14:25	14:25
31-Jul	31-Jul	31-Jul	8-Aug	13-Aug	13-Aug	21-Aug	21-Aug
not purged	not purged	not purged	not purged	not purged	not purged	not purged	not purged
				20	30		
30			50				
						20	20
40			20	20	20		
	100	100					
30							
						20	30
	20	20					
20							
	50	70		30	30	30	30
	20	20	20	10	20		
	20	20		20	20	20	20
20							
20			30	30	30		
	6	7	8				
30				10	9	9	9
20	10	20					
7	9	9					
10							
						10	20
10							
			30	20	10		
	40	200				70	50
	10	10					
			30	20	10		

Sheet1

30	10	10					
9							
						10	10
10							
				20	20	20	20
20							
	8	7					
	8	7					
			10	10	9	30	20
	7	6					
				20	20	10	10
			20				
			40	20	20	20	10
			40				
			20				
	30	20	30	40	40	20	20
			20	20	20	20	20
						7	7
			20				

## APPENDIX E

Precision Analytical Laboratory, Inc.  
VOC Results  
Standard Compounds

## Sheet2

Site		Trans	Trans	Savner	Savner	Dover	Dover
Bucket ID		P7-4	PD7-4	P6-1	PD6-1	P9-1	PD9-1
Date Sampled		16-Oct	16-Oct	15-Oct	15-Oct	22-Jul	22-Jul
Time of Day Sampled		2:22	2:22	1:40	1:40	11:30	11:30
Date Analyzed		17-Oct	17-Oct	16-Oct	16-Oct	23-Jul	23-Jul
Compounds	CAS #	purged	purged	purged	purged	not purged	not purged
Chloromethane	74-87-3	1.4	1.5	1.5	1.5	1	1
Vinyl chloride	75-01-4						
bromomethane	74-83-9						
chloroethane	75-00-3						
acetone	67-64-1	21	20	18	19	10	10
trichlorofluoromethane	75-69-4	1.9	2.1	1.8	1.8	1.6	1.6
1,1-dichloroethene	73-35-4						
methylene chloride	75-09-2	2.2	2.2	1.5	1.6	2.4	2.4
trichlorotrifluoroethane	76-13-1	0.72tr	0.82tr	1	0.91tr	0.82tr	.83tr
carbon disulfide	75-15-0	1.7	1.7	1.6	2.2	6	6.1
trans-1,2-dichloroethene	156-60-5						
1,1-dichloroethane	75-34-3						
methyl tert-butyl ether	1634-04-4						
vinyl acetate	108-05-4						
2-butanone (Methyl Ethyl Ke	78-93-3	9.7	10	9.7	9.8	2.8	3.1
cis-1,2-dichloroethene	156-59-2						
chloroform	67-66-3						
1,2-dichloroethane	107-06-2						
1,1,1-trichloroethane	71-55-6	0.97tr	0.88tr	0.78tr	0.83	1	1.1
benzene	71-43-2	6.7	6.6	2.7	2.6	2.1	2.2
carbon tetrachloride	56-23-5	0.69tr	0.66tr	0.60tr	0.65tr	.66tr	.69tr
1,2-dichloropropane	78-87-5						
bromodichloromethane	75-27-4						
trichloroethene	79-01-6	2.6	2.3	0.81tr	0.78tr		
cis-1,3-dichloropropene	0061-01-						
4-methyl-2-pentanone (meth	108-10-1	0.72tr	0.70tr				
trans-1,3-dichloropropene	0061-02-						
1,1,2-trichloroethane	79-00-5						
toluene	108-88-3	22	22	13	13	10	10
2-hexanone	591-78-6						
dibromochloromethane	124-48-1						
1,2-dibromoethane	106-93-4						
tetrachloroethene	127-18-4	1.3	1.2				
chlorobenzene	108-90-7						
ethylbenzene	100-41-4	4.8	4.7	3.3	3.3	1.1	1.2
m- & p-xylene	1330-20-7	16	16	11	11	4.2	4.3
bromoform	75-25-2						
styrene	100-42-5					.56tr	.55tr
o-xylene	95-47-6	5.3	5.3	3.3	3.2	1.3	1.2
1,1,2,2-tetrachloroethane	79-34-5						
1,3-dichlorobenzene	541-73-1						
1,4-dichlorobenzene	106-46-7						
1,2-dichlorobenzene	95-50-1						



Sheet2

Site		Davies	Davies	Dover	Dover	Orton	Orton
Bucket ID		P8-2	PD8-2	P5-4	PD5-4	P7-3	PD7-3
Date Sampled		30-Jul	30-Jul	11-Aug	11-Aug	19-Aug	19-Aug
Time of Day Sampled		13:33	13:33	15:20	15:20	14:25	14:25
Date Analyzed		31-Jul	31-Jul	13-Au	13-Aug	21-Aug	21-Aug
Compounds	CAS #	not purged	not purged	not purged	not purged	not purged	not purged
Chloromethane	74-87-3	1.5	1.6	1.6	1.5	1.8	1.7
Vinyl chloride	75-01-4						
bromomethane	74-83-9						
chloroethane	75-00-3						
acetone	67-64-1	26	25	48	45	35	37
trichlorofluoromethane	75-69-4	2	2.1	2.1	2	1.8	1.7
1,1-dichloroethene	73-35-4						
methylene chloride	75-09-2	15	16	8.7	8.2	3.9	3.8
trichlorotrifluoroethane	76-13-1	1.0tr	1	.87tr	0.79tr	0.81tr	0.91tr
carbon disulfide	75-15-0	7.3	7.7	8.9	8.6	7.3	7.8
trans-1,2-dichloroethene	156-60-5						
1,1-dichloroethane	75-34-3						
methyl tert-butyl ether	1634-04-4	.81tr	.8tr				
vinyl acetate	108-05-4						
2-butanone (Methyl Ethyl Keto)	78-93-3	4.1	4.1	9	8.6	8.6	8.9
cis-1,2-dichloroethene	156-59-2						
chloroform	67-66-3						
1,2-dichloroethane	107-06-2						
1,1,1-trichloroethane	71-55-6	27	28	9.8	8.9	3.2	3.5
benzene	71-43-2	2.4	2.5	2.9	2.7	4.4	4.5
carbon tetrachloride	56-23-5	.75tr	.73tr	.78tr	0.75tr	0.65tr	0.63tr
1,2-dichloropropane	78-87-5						
bromodichloromethane	75-27-4						
trichloroethene	79-01-6	.75tr	.76tr	1.6	1.6	2.1	2.4
cis-1,3-dichloropropene	0061-01-						
4-methyl-2-pentanone (methyl)	108-10-1	1.1	1.1	0.68tr	0.62tr	1.2	1.2
trans-1,3-dichloropropene	0061-02-						
1,1,2-trichloroethane	79-00-5						
toluene	108-88-3	27	28	38	36	25	25
2-hexanone	591-78-6						
dibromochloromethane	124-48-1						
1,2-dibromoethane	106-93-4						
tetrachloroethene	127-18-4	.79tr	.79tr	0.82tr	0.81tr	0.74tr	0.77tr
chlorobenzene	108-90-7						
ethylbenzene	100-41-4	1.5	1.6	4.3	4.3	2.2	2.1
m- & p-xylene	1330-20-7	5	5	17	16	6.6	6.3
bromoform	75-25-2						
styrene	100-42-5	1.8	1.8	2.1	2	41	41
o-xylene	95-47-6	1.6	1.7	5.1	4.9	2	2
1,1,2,2-tetrachloroethane	79-34-5						
1,3-dichlorobenzene	541-73-1						
1,4-dichlorobenzene	106-46-7						
1,2-dichlorobenzene	95-50-1						

## APPENDIX F

Precision Analytical Laboratory, Inc.  
VOC Results  
Tentatively Identified Compounds

Sheet1

Tentatively LD.d compds							
Site		Trans	Trans	Savier	Savier	Dover	Dover
Bucket ID		P7-4	PD7-4	P6-1	PD6-1	P9-1	PD9-1
Date Sampled		16-Oct	16-Oct	15-Oct	15-Oct	22-Jul	22-Jul
Time of Day Sampled		2:22	2:22	1:40	1:40	11:30	11:30
Date Analyzed		17-Oct	17-Oct	16-Oct	16-Oct	23-Jul	23-Jul
Compounds	CAS #	purged	purged	purged	purged	not purged	not purged
carbonyl sulfide + propane		30	20				
carbonyl sulfide						20	10
Dichlorodifluoromethane							
propane							
acetaldehyde + isobutane							
acetaldehyde	75-07-0						
isobutane		40	40	4	5		
fluorotrimethylsilane							
butane		200	200				
n-butane				20	20		
ethanol		20	20	20	20		
isopentane				10	10		
isopropanol						20	20
unidentified chlorofluorocarbon							
2-methylbutane		100	100				
isopropyl alcohol		8	7				
pentane		60	60			20	20
n-pentane				6	6		
trimethylsilanol							
Methylcyclobutane + C6 Branched Alkane							
2-Methylpentane		30	9	4	4	20	20
3-Methylpentane		9	9				
n-hexane						7	8
hexene		9	9				
tetrahydrofuran							
Methylcyclopentane		10	10				
Methyl Methacrylate				4	4		
1-butanol				3	3		
3-Methylhexane		6	6				
Hexanal							
n-Octane				3	4		
C9H20 branched alkane							
Octane							
hexamethylcyclotrisiloxane				10	10	8	8
C9H20 branched alkane						10	10
C9 branched alkane						10	10
N,N-Dimethyl Acetamide (possible artifact)							
decane						5	5
C9 branched alkane							
C9H20 branched alkane							
C9H20 branched alkane							

unidentified silane or siloxane						8	7
n-Decane				8			
Tentatively I.D.d compds							
Site		Trans	Trans	Savir	Savir	Dover	Dover
Bucket ID		P7-4	PD7-4	P6-1	PD6-1	P9-1	PD9-1
Date Sampled		16-Oct	16-Oct	15-Oct	15-Oct	22-Jul	22-Jul
Time of Day Sampled		2:22	2:22	1:40	1:40	11:30	11:30
Date Analyzed		17-Oct	17-Oct	16-Oct	16-Oct	23-Jul	23-Jul
Compounds	CAS #	purged	purged	purged	purged	not purged	not purged
Phenol (possible artifact)		9	10			10	20
1-octanol				10			
C12H26 branched alkane						10	9
unidentified Silane or Siloxane							
n-undecane							
C12H26 branched alkane						10	10
C12H26 branched alkane							
3-ethyltoluene				4	4		
1,2,4-Trimethylbenzene		4	4				
6-Methyl-5-hepten-2-one							
Decane							
C10H20Alkene							
C11-H24 Branched Alkane							
unidentified silane or siloxane				8	5	10	10
Octanal							
n-Decane					8		
d-limonene							
1-Octanol					10		
C12 Branched Alkane		6	7				
C13 branched alkane							
C13H28 branched alkane							
Nonanal							
C12H26+A103 Branched Alkane							
n-Undecane							
Undecane							
C8-C9 aldehyde+C10H14 Alkyl substituted benzene							
C12branched alkane							
C13 branched alkane							
C13-C14 branched alkane							
unidentified silane or siloxane							
Cyclohexyl Isothiocyanate				4	3		
Octyl Acetate							
dodecane							
C14-C15 branched alkane							
C14 branched alkane						6	6

Tentatively I.D.d compds							
Site		Davies	Davies	Dover	Dover	Orton	Orton
Bucket ID		P8-2	PD8-2	P5-4	PD5-4	P7-3	PD7-3
Date Sampled		30-Jul	30-Jul	11-Aug	11-Aug	19-Aug	19-Aug
Time of Day Sampled		13:33	13:33	15:20	15:20	14:25	14:25
Date Analyzed		31-Jul	31-Jul	13-Aug	13-Aug	21-Aug	21-Aug
Compounds	CAS #	not purged	not purged	not purged	not purged	not purged	not purged
carbonyl sulfide + propane				20	30		
carbonyl sulfide							
Dichlorodifluoromethane							
propane							
acetaldehyde + isobutane						20	20
acetaldehyde	75-07-0			20	20		
isobutane		100	100				
fluorotrimethylsilane							
butane						20	30
n-butane							
ethanol		20	20				
isopentane							
isopropanol							
unidentified chlorofluorocarbon							
2-methylbutane		50	70	30	30	30	30
isopropyl alcohol		20	20	10	20		
pentane		20	20	20	20	20	20
n-pentane							
trimethylsilanol							
Methylcyclobutane + C6 Branched Alkane							
2-Methylpentane				30	30		
3-Methylpentane							
n-hexane		6	7				
hexene				10	9	9	9
tetrahydrofuran		10	20				
Methylcyclopentane							
Methyl Methacrylate							
1-butanol							
3-Methylhexane							
Hexanal							
n-Octane		9	9				
C9H20 branched alkane							
Octane						10	20
hexamethylcyclotrisiloxane							
C9H20 branched alkane							
C9 branched alkane				20	10		
N,N-Dimethyl Acetamide		40	200			70	50
decane		10	10				
C9 branched alkane				20	10		
C9H20 branched alkane							
C9H20 branched alkane							

unidentified silane or	10	10				
n-Decane						
Tentatively I.D.d compds						
Site		Davies	Davies	Dover	Dover	Orton
Bucket ID		P8-2	PD8-2	P5-4	PD5-4	PD7-3
Date Sampled		30-Jul	30-Jul	11-Aug	11-Aug	19-Aug
Time of Day Sampled		13:33	13:33	15:20	15:20	14:25
Date Analyzed		31-Jul	31-Jul	13-Aug	13-Aug	21-Aug
Compounds	CAS #	not purged	not purged	not purged	not purged	not purged
Phenol (possible artifact)					10	10
1-octanol						
C12H26 branched alkane						
unidentified Silane or Siloxane				20	20	20
n-undecane						
C12H26 branched alk	8	7				
C12H26 branched alk	8	7				
3-ethyltoluene						
1,2,4-Trimethylbenzene						
6-Methyl-5-hepten-2-one						
Decane				10	9	30
C10H20Alkene						
C11-H24 Branched Alkane						
unidentified silane or siloxane						
Octanal						
n-Decane						
d-limonene	7	6				
1-Octanol						
C12 Branched Alkane			20	20	10	10
C13 branched alkane						
C13H28 branched alkane						
Nonanal						
C12H26+A103 Branched Alkane						
n-Undecane						
Undecane						
C8-C9 aldehyde+C10H14 Alkyl substituted benzene						
C12 branched alkane			20	20	20	10
C13 branched alkane						
C13-C14 branched alkane						
unidentified silane or	30	20	40	40	20	20
Cyclohexyl Isothiocyanate						
Octyl Acetate			20	20	20	20
dodecane					7	7
C14-C15 branched alkane						
C14 branched alkane						

## APPENDIX G

### Odor Survey

## Odor Survey - North Portland - 1998

**Monitor's Name:**

**Location:**

**Date:**

**Time:**

**Wind direction:**

**Description of odor:**

- \_\_\_\_\_ 1. metallic
- \_\_\_\_\_ 2. rotten eggs/sulfur
- \_\_\_\_\_ 3. paint/chemical
- \_\_\_\_\_ 4. other

**Duration:**

**Odor intensity:**

- \_\_\_\_\_ 1. No physical symptoms, not enough to draw attention
- \_\_\_\_\_ 2. No physical symptoms, you would get up and shut windows or doors
- \_\_\_\_\_ 3. Eyes and throat hurt slightly, prefer to leave situation at first opportunity
- \_\_\_\_\_ 4. May cause nausea as well as burning eyes and throat, want to leave immed.

**Have you smelled odor before?**

**Do you suspect a source? Why?**

**Other comments:**

**Instructions/suggestions:**

1. Fill out only one sheet per day
2. Monitor is not expected to stay outside until odor dissipates
3. Estimation of duration is up to monitor. e.g. if you detect when you first step outside go about your regular routine, but try to step outside again in half an hour. note odor then
4. Bob Amundson will pick up sheets weekly - he can be reached at 241-7275



## Dates when odors detected and recorded on odor forms

June	July	August
1	1 x	1
2 xx	2	2
3	3 x	3
4	4	4 xx
5 x	5	5 xxx
6 x	6	6
7	7 xx	7 x
8	8	8
9 x	9 xx	9
10	10 x	10
11	11 xx	11 x
12	12	12 xx
13	13 x	13 x
14	14 x	14 x
15	15 x	15
16	16	16
17	17	17
18	18	18 x
19 x	19	19 x
20	20	20
21	21 xx	21 x
22	22 xxx	22
23	23 x	23
24	24 x	24
25	25 x	25
26	26	26
27	27	27
28	28	28
29	29 xx	29 x
30 x	30 x	30
	31 xx	31

Odor Description	# of observations	Identified Sources	
burning electrical	5		
burning rubber	4		
burnt unknown	7	foundry	14
burnt coffee/toast	9	localized	3
car exhaust	3		
ozone	5		
welding	1		
chemical	8		
metallic	6		

Note: multiple descriptions were sometimes used on same form

## APPENDIX H

### Complete Particulate Mass Results

## Study Particulate Data (ug/M3)

Permanent city-wide HV  
PM10 data (ug/M3)

Site No.	9726002	9726003	9726003	9726004	9726005	9726006	9726008	9726007	9726001	9726001	9726001	9726001	9726001	9726001	9726001	2614230	2614238	2614123	2614101	300101
Site Mnemonic	TTT	ASPEN	ASPEN	CHAPMAN	AWNING	SUSHI (moved to Genasci)	GENASCI (moved from Sushi)	ROVER	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	SEL	TTT	CFS	RHS	SPR
Sampler type	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 quartz (Phase 1 only)	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon (Duplicate)	Survey (5 bpm) PM2.5 Teflon (Special for Phase 2)	Survey PM2.5 quartz (Phase 1 only)	MV PM2.5 Teflon	MV PM2.5 Quartz	MV PM10 Quartz	HV PM10*	HV PM10	HV PM10	HV PM10	HV PM10
Phase 1 (Survey samplers used single stage inlets)																				
7/9/97	ND	ND		ND	19	11			17	15			7	10	ND	10	19	12	12	8
7/10/97													6	12	14					
7/11/97													7	11	18					
7/12/97													7	11	16					
7/13/97													12	16	21					
7/14/97													ND	ND	22					
7/15/97	ND	8		ND	10	16			11	16			8	20	19	12	26	16	12	12
7/16/97													13	26	25					
7/17/97													14	17	26					
7/18/97													11	18	24					
7/19/97													18	22	27					
7/20/97													17	24	27					
7/21/97	20	ND		ND	ND	ND			19	ND			14	15	17	23	32	27	24	23
7/22/97													12	13	21					
7/23/97													10	13	28					
7/24/1997 OrCPR forecast day (12 hr)	31	17		20	25	25		22	34	23			20	20	30					
7/24/97													17	17	29					
7/25/97													ND	ND	22					
7/26/97													12	21	20					
7/27/97	14	11		13	15	17			13	15			13	22	20	18	22	21	17	19
7/28/97													ND	ND	26					
7/29/97													ND	ND	26					
7/30/97													12	16	24					
7/31/97													11	18	26					
8/1/97												26	17	22	26					
8/2/97	16	20	12	18	16	18			16	11		19	9	16	19	17	20	20	27	18
8/3/97													9	7	22					
8/4/97													14	12	27					
8/5/97													16	20	35					
8/6/97													12	18	33					
8/7/97													10	13	25					
8/8/97	16	5	25	21	ND	17			15	18		11	10	15	23	20	31	ND	25	18
8/9/97													9	14	27					
8/10/97													10	16	21					

## Study Particulate Data (ug/M3)

Permanent city-wide HV  
PM10 data (ug/M3)

Site No.	9726002	9726003	9726003	9726004	9726005	9726006	9726008	9726007	9726001	9726001	9726001	9726001	9726001	9726001	9726001	2614230	2614238	2614123	2614101	300101
Site Mnemonic	TTT	ASPEN	ASPEN	CHAPMAN	AWNING	SUSHI (moved to Genasci)	GENASCI (moved from Sushi)	ROVER	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	SEL	TTT	CFS	RHS	SPR
Sampler type	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 quartz (Phase 1 only)	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon (Duplicate)	Survey (5 lpm) PM2.5 Teflon (Special for Phase 2)	Survey PM2.5 quartz (Phase 1 only)	MV PM2.5 Teflon	MV PM2.5 Quartz	MV PM10 Quartz	HV PM10*	HV PM10	HV PM10	HV PM10	HV PM10
8/11/1997 Clean Air Action Day (12 hr)	40	ND	34	39	25	ND			ND	28		8	21	25	44					
8/11/97									29				20	24	34					
8/12/1997 Clean Air Action Day (12 hr)	30	30	38	24	27	33			24	26		34	19	16	42					
8/12/97													18	16	34		43			
8/13/97													19	23	35					
8/14/1997 Clean Air Action Day	41	26	ND	ND	23	34			21	30		ND	22	26	47					
8/14/97													20	30	39	27	44	34	36	33
Phase 2																				
10/1/97	ND	ND		12	ND		ND		12	15	11		18	17	ND	20	36	28	26	15
10/2/97													10	18	19					
10/3/97													7	10	13					
10/4/97													5	8	10					
10/5/97													7	14	14					
10/6/97													12	17	21					
10/7/97	13	8		14	10		10		11	10	13		12	16	20	22	ND	21	23	12
10/8/97													11	18	8					
10/9/97													6	10	12					
10/10/97													10	14	12					
10/11/97													8	14	13					
10/12/97													10	13	17					
10/13/97	17	9		11	12		15		17	16	21		20	21	33	ND	35	32	26	14
10/14/97													22	28	37					
10/15/1997 Clean Air Action Day (12 hr)	ND	29		22	21		28		ND	ND	ND		32	43	49					
10/15/97	29								30	26	22		29	38	46					
10/16/97													36	40	63					
10/17/97													25	27	42					
10/18/97													12	15	20					
10/19/97	21	ND		16	14		12		20	19	21		19	21	27	22	31	29	23	24
10/20/97													27	29	41					
10/21/97													32	37	47					
10/22/97													38	38	50					
10/23/97													14	17	21					
10/24/97													26	28	36					

## Study Particulate Data (ug/M3)

Permanent city-wide HV  
PM10 data (ug/M3)

Site No.	9726002	9726003	9726003	9726004	9726005	9726006	9726008	9726007	9726001	9726001	9726001	9726001	9726001	9726001	9726001	9726001	2614230	2614238	2614123	2614101	300101
Site Mnemonic	TTT	ASPEN	ASPEN	CHAPMAN	AWNING	SUSHI (moved to Genasci)	GENASCI (moved from Sushi)	ROVER	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	SEL	TTT	CFS	RHS	SPR
Sampler type	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 quartz (Phase 1 only)	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon (Duplicate)	Survey (5 lpm) PM2.5 Teflon (Special for Phase 2)	Survey PM2.5 quartz (Phase 1 only)	MV PM2.5 Teflon	MV PM2.5 Quartz	MV PM10 Quartz	HV PM10*	HV PM10	HV PM10	HV PM10	HV PM10	
10/25/97	23	16		23	22		26		30	29	33		26	31	37	30	35	45	39	12	
10/26/97													34	38	39						
10/27/97													31	43	40						
10/28/97													25	28	34						
10/29/97													11	12	20						
10/30/97													7	12	15						
10/31/97	16	11		9	11		12		ND	ND	ND		ND	ND	ND	24	32	ND	22	17	
11/4/1997 Clean Air Action Day (12 hr)	ND	19		19	17		24		29	20	33		25	36	43						
11/4/97													23	37	42						
Phase 3																					
1/9/98													15	21	24						
1/10/98													17	24	24						
1/11/98													7	8	11	31	16	10	14	8	
1/12/98													11	12	11						
1/13/98													23	24	26						
1/14/98													15	16	16						
1/15/98													15	18	38						
1/16/98													26	26	43						
1/17/98	10	ND		6	7		11		10	9			8	11	19	18	24	ND	18	14	
1/18/98													6	11	11						
1/19/98													4	ND	7						
1/20/98													15	ND	14						
1/21/98													8	8	12						
1/22/98													13	12	21						
1/23/98	14	6		4	7		6		7	5			7	8	12	7	30	13	10	5	
1/24/98													6	2	8						
1/25/98													8	10	12						
1/26/98													13	13	21						
1/27/98													12	17	24						
1/28/98													7	8	16						
1/29/98	11	4		4	6		5		6	7			6	9	10	8	28	13	13	6	
1/30/98													9	13	20						
1/31/98													5	9	12						
2/1/98													8	8	12						
2/2/98													8	10	15						
2/3/98													9	11	21						

# Study Particulate Data (ug/M3)

Permanent city-wide HV  
PM10 data (ug/M3)

Site No.	9726002	9726003	9726003	9726004	9726005	9726006	9726008	9726007	9726001	9726001	9726001	9726001	9726001	9726001	9726001	2614230	2614238	2614123	2614101	300101
Site Mnemonic	TTT	ASPEN	ASPEN	CHAPMAN	AWNING	SUSHI (moved to Genascl)	GENASCI (moved from Sushi)	ROVER	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	FHPO	SEL	TTT	CFS	RHS	SPR
Sampler type	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 quartz (Phase 1 only)	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon	Survey PM2.5 Teflon (Duplicate)	Survey (5 lpm) PM2.5 Teflon (Special for Phase 2)	Survey PM2.5 quartz (Phase 1 only)	MV PM2.5 Teflon	MV PM2.5 Quartz	MV PM10 Quartz	HV PM10*	HV PM10	HV PM10	HV PM10	HV PM10
2/4/98	14	3		4	8		6		8	9			7	9	17	10	31	17	14	7
2/5/98													8	9	13					
2/6/98													6	6	11					
2/7/98													6	ND	11					
2/8/98													3	4	5					
2/9/98													9	10	15					
2/10/98	10	3		5	8		6		6	6			5	8	8	7	22	10	11	3
2/11/98													6	8	10					
2/12/98													5	6	8					
2/13/98													7	9	11					
2/14/98													ND	ND	10					
2/15/98													5	8	9					
2/16/98	15	4		4	6		6		6	7			5	7	11	10	38	11	14	6
2/17/98													5	2	12					
2/18/98													9	10	11					

Underlined data is from short (~12 hours) sampling periods.

\* HV PM10 data not available from SEL after Oct 1, 1997. MV PM10 data substituted after that date.

NWPDX 97-98 mass summary. Bvj

## APPENDIX I

### ESCO Odor Investigation Letter

JUL 1 1997



## NORTHWEST REGION

ESCO CORPORATION 2141 N.W. 25TH AVENUE P.O. BOX 10123 PORTLAND, OREGON 97210 U.S.A. TELEPHONE: (503) 228-2141

June 30, 1997

Frank Bird, President of the Board  
Members of the Board  
NORTHWEST DISTRICT ASSOCIATION  
1819 NW Everett St. #205  
Portland, OR 97209

Dear Frank and Members of the Board:

For the past 20 months ESCO has been addressing potential odor issues at its Main Plant on 25th and Vaughn, and at Plant 3 on Yeon. We met with the Board when we began these efforts and I want to update you on our progress.

As you know, our Main Plant is across the street from Northwest Portland's commercial and residential neighborhood, and odors from our foundry sometimes reach the neighborhood. Odors can be noticeable even though the ESCO plants have excellent pollution control equipment and meet all health and safety standards. Most steel foundries are in heavy industrial areas where odors are normal and expected. While ESCO is in a heavy industrial area, we are unusual in that we abut the commercial and residential area where expectations may be different.

Odor is a difficult problem because the human nose can detect odors, both good and bad, at very low levels. Individual perception plays a huge role in determining whether an odor is acceptable or objectionable, unnoticed or highly irritating. With this in mind, we began working with odor specialists to develop plans to identify the source of odors at the plant. We successfully identified the source of odors, and are now working on solutions.

Here's our progress so far:

- ESCO worked with odor experts to develop a scientific approach for identifying sources of odor. We had our guesses, but felt it was important to scientifically identify the sources. We're happy we took this approach, because there were a few significant surprises.
- Air samples were collected from 24 potential problem areas, and were taken at different times and during different processes. The samples were sent to an independent lab where an odor panel, a group of highly trained professionals, smelled and analyzed each sample.
- Results show that to the extent odors are reaching the neighborhood from ESCO, the most likely source is an operation near 25th and Vaughn called the "Doghouse" (because it's shaped like a doghouse). ESCO recycles scrap steel, melts it, then pours the molten steel into sand molds to form new steel parts.



June 30, 1997  
Page 2

When the steel has cooled, the molds are broken open in a "shakeout system" on the Doghouse floor.

A binder is used to hold the sand molds together, and when 3000° F molten steel is poured into the molds it burns the binder, creating odor. The odor is released when the molds are broken. We discovered that the most pungent and noticeable odor occurs when molds for manganese steel chain, a large chain used in shipping and construction, are broken. Manganese steel chain molds are unusual because they require an oil-based binder which has a pungent burned oil smell evident at dilute levels.

We routinely conduct industrial hygiene sampling, and the results do not show any negative health impacts. However, this does not negate the possibility that some neighbors may find the odors objectionable.

- We have identified how the most noticeable odors are escaping. ESCO uses pollution control technology called "baghouses" which capture dust and other "particulate" created in our processes. The baghouses pull in air from the plant and collect over 99% of the particulate.

When the baghouses pull in air and clean it of particulate, they also pull in odors. However, baghouses are not designed to capture odors, and some of the odors escape into the neighborhood. The process by which odor reaches the neighborhood was a surprise, and one that gives us useful information about how to address the problem.

Based on our findings, we're taking three steps to reduce odor:

1. We are investigating new oil-free binders for manganese chain. Obviously the best way to reduce odor is to not create it in the first place. We are aggressively pursuing several options that have potential to minimize odor while maintaining product quality.
2. We have replaced the filtration systems on our baghouses. While the systems are not designed to capture odors, we believe that new filtration systems may help somewhat.
3. Beginning this month we will be installing a spray system inside the Doghouse designed to neutralize odors. The system uses a natural plant oil extract to neutralize odors before they reach the baghouse. We will be monitoring this system and evaluating its effectiveness throughout the summer.

We don't have all the answers yet, but we're getting there. We take our relationship with our neighborhood very seriously and we want that relationship to be a good one.

I know that for those who have complained about odors in the neighborhood this is taking longer than they would have wanted. We wish that there was a quick and easy solution. But eliminating odor in a large heavy industrial facility is neither easy nor inexpensive. We

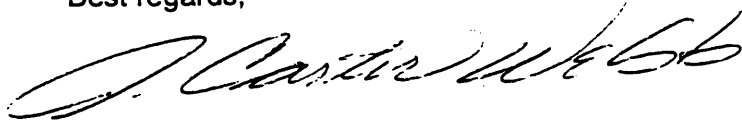
June 30, 1997

Page 3

already have a huge investment in this project and we will continue to work until odor is reduced.

We will also continue to keep you posted on our progress.

Best regards,

A handwritten signature in black ink, appearing to read "J. Carter Webb". The signature is fluid and cursive, with the first name "J." being small and the last name "Webb" being larger and more prominent.

J. Carter Webb, Manager  
Environmental/Safety Affairs

cc: Sharon Genasci, Chair, and Members of the NWDA Health and Environment Committee  
Doug MacGowan  
Beth Moore, Oregon Department of Environmental Quality

## APPENDIX J

### Faulkner Automotive Electric Company Pollution Prevention Success Story

# Faulkner Automotive Electric Company

## *Pollution Prevention Success Story*

### BACKGROUND

Faulkner Automotive Electric Company remanufactures electric automotive parts, such as starters and alternators, in northwest Portland. Faulkner's facility has been at the same location since 1926.

In the past several years, new residential housing units have been constructed in the neighborhood near Faulkner's facility. Some of the neighbors raised concerns about chemical odors from the facility in the fall of 1997.

In responding to the concerns, DEQ staff found the company very interested in identifying and solving any potential problem. As a result, representatives from the Department's Air Quality and Toxic Use Reduction sections conducted a technical assistance visit to work with the company to determine if the odor could be eliminated at the source.

### THE ENVIRONMENTAL CHALLENGE

After touring the Faulkner facility, it was determined that the main source of odors was a volatile component in a resin-like varnish used to coat the wires of certain electric parts. This flammable and volatile varnish cured on the wires quickly and effectively.

Any substitute product would need to demonstrate equal curing and durability properties. Several

potential substitutes were identified and a few were tested. Faulkner found a water-based alternative that met its performance criteria, with some process modifications.

Since this alternative was less volatile, additional heat was required to ensure adequate and fast curing of the material. Rather than increasing the temperature of the varnishing units significantly, Faulkner found a way to enclose these units to trap the heat, thus achieving the temperature change without increased energy useage.

### ENVIRONMENTAL RESULTS

The environmental benefits from the switch to a water-based varnish and enclosure of the varnishing units were the following:

- ♦ Elimination of their nuisance odor in the neighborhood.
- ♦ Decrease in emissions of volatile hazardous air pollutants from **4,400 pounds** to **328 pounds** per year – a **92%** decrease in emissions.

The new varnish contains a much smaller percentage of volatile compounds than the solvent-based material. In addition, much less of the new varnish is needed per unit of production. Faulkner's varnish use rate has fallen from 15 gallons per week to 5 gallons every two weeks – an 83% reduction.

Faulkner also fully enclosed their solvent parts washing unit to further

minimize volatile organic emissions from the facility and to conserve product.

### ECONOMIC BENEFITS

The resulting economic benefits from this product substitution and equipment modification are equally substantial. Although, Faulkner now pays about \$6 more per gallon for the new varnish, the huge reduction in usage has resulted in a major net cost savings for the company. Faulkner realized the following estimated economic benefits:

- ♦ **\$8,475** in avoided annual purchases of varnish product.
- ♦ A payback period of **less than 3 months** for the capital investment necessary to modify the varnishing units.
- ♦ No net increase in energy expenses, despite the need for additional heat to cure the varnish.

The experience of Faulkner illustrates how businesses, government agencies, and local communities can work together to solve environmental problems in a way that benefits all parties.

### FOR MORE INFORMATION

Contact these DEQ staff:

Kevin Masterson  
(503) 229-5615

Beth Moore  
(503) 229-5586

